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UNIVERSITY EDUCATION IN CENTRAL AFRICA

IN 1938 a Royal Commission under Lord Bledisloe's chairmanship considered the question of closer association between the Central African territories of Southern Rhodesia, Northern Rhodesia and Nyasaland and recommended the setting up of an inter-territorial Council, charged with co-ordinating the existing Government services and with surveying the plans for development in the whole area. Because of the War, the recommendations of this Commission could not be acted upon immediately; but in 1945 the Central African Council was established with the object of promoting the closest possible contact and co-ordination of policy and action between the three territories in all matters of common interest. In 1949 the Central African Council appointed a special committee under the chairmanship of Sir Harold Cartmel-Robinson to consider the need for facilities for higher education for Africans in Central Africa. The report of this special committee, presented in November 1949, recommended that such facilities should be made available and that a Commission should be appointed to advise in detail on the steps needed to implement its recommendation. No action was taken at that time on this or any other recommendation in the report of this committee.

In 1950, the Government of the Union of South Africa decreed that because the educational facilities of the indigenous population within the Union were inadequate, native students from territories outside the Union would no longer be admitted to educational institutions in the Union after the end of 1953. The Central African Council then asked the Special Committee on Higher Education for Africans (the Cartmel-Robinson Committee) to reopen its inquiries. The Committee revised its earlier report, and in April 1951 again recommended that a Commission be appointed to consider the situation. In September 1952 a Commission was appointed, under the chairmanship of Sir Alexander Carr-Saunders, to report to the Central African Council on the general question of higher education for Africans in Central Africa, and in particular to make proposals concerning a college for Africans in the Central African territories; the Commission has recently published its report*.

The Commission urges in this report that a university college should be founded without delay, and that it should be worthy to take its place by the side of those instituted with such success in the past decade in East Africa and the West Indies, Nigeria and the Gold Coast. The need for such a college is clear. There is a sufficient and increasing output from the secondary schools of the three territories, and the college would almost certainly attract students from the High Commission territories (Bechuanaland, Basutoland, Swaziland) as well as from Belgian and Portuguese territories, and even from the Union of South Africa. The Commission

* Report of the Commission on Higher Education for Africans in Central Africa. Pp. iv+94. (London: Crown Agents for the Colonies, Millbank, S.W.1.) 5s.

forecasts that if the minimum entrance standard were a good performance in the Cambridge Overseas School Certificate Examination, the college might expect to admit a hundred Africans a year in 1957; thereafter the number should increase substantially. For university-educated Africans there are many openings, and these will increase with time. The Commission accepts the view laid down in the Asquith report (Cmd. 6647. H.M.S.O., June 1945), which, in discussing the general question of university education in the Colonies, states: "In our view it is essential that Colonial Universities should be autonomous, in the sense in which the Universities of Great Britain are autonomous. . . . The Colonial Universities should, in effect, have full freedom to manage their own affairs". Nevertheless, as a first step it is suggested that the college to be instituted should enter into special relationship with the University of London; this would permit concessions in the standard of entrance, but would ensure that there was no lowering of the degree standard. It would therefore be expected that an average student would spend four years within the walls of the college. But this should be only the first step in the founding of a full and autonomous university, and the university must be so sited that it could expand to a size and stature adequate for all the future university needs of Central Africa. The Commission therefore recommends that a site should be at least two square miles (1,280 acres) in area, and that the college should be established by Royal Charter, a step which would guarantee both autonomy and provision for steady growth. The usual departments in arts and sciences should be instituted at the start, and the academic staff at the end of the first five-year period is estimated at seventy-two. The Commission attaches great importance to the development of research work and to the need for a good library.

The report most significantly recommends that the university college to be established in Central Africa should be multi-racial. It states: "It is contrary to University tradition to have regard to race, religion or class when selecting candidates for admission".

In discussing where the multi-racial university college could be situated, the Commission states its view that Salisbury, Southern Rhodesia, should if possible be the centre to which the college be related. But the task of the Commission was complicated by the existence of a scheme sponsored by the legislature of Southern Rhodesia for the founding of a Rhodesian University. The decision to institute such a university was taken in 1946 when the Legislative Assembly of Southern Rhodesia resolved that as soon as practicable a Rhodesian University should be established to serve the two Rhodesias and neighbouring territories, and in 1947 the governor of Southern Rhodesia established a Rhodesian University Foundation Fund and appointed trustees. In 1952 the Legislative Assembly of Southern Rhodesia passed an Act entitled "The University Charter and Inaugural Board (Private) Act", by which an inaugural board was set up. The trustees of the Rhodesian University Foundation Fund state that they have received gifts of something like £300,000, and the city of Salisbury has given a site of 250 acres for the proposed university. Queen Elizabeth the Queen Mother is laying the foundation stone of the first building during her visit to Southern Rhodesia. The Carr-Saunders Commission pays warm tribute to those responsible for this imaginative and public-spirited act on the part of the settlers in Southern Rhodesia, and welcomes the Rhodesian University as a basis of the proposed Central African University, provided its sponsors incorporate in their plans the elements which it deems essential, namely: (1) that it should be multi-racial; (2) that it should be autonomous; and (3) that it should be capable of expansion to the desirable extent by being placed on a site of at least 1,280 acres.

The Cartmel-Robinson Committee had discussed the relationship of the university college proposed for the higher education of Africans and the Rhodesian University, and had suggested the possibility that both these institutions be sited in or near Salisbury, and that there should be a link between them. This proposal the Carr-Saunders report rejects for a number of reasons, but particularly because the Rhodesian University would not be autonomous, because the proposal could clearly lead to racial segregation, and because the dissipation of resources between the two colleges would fail absolutely to bring into being a university worthy of Central Africa. The Carr-Saunders Commission is not unanimous on this point, since one of its members, Dr. Alexander Kerr, formerly principal of the South Africa Native College at Fort Hare, states in a note of reservation that "nothing in the past history of these or neighbouring Territories justifies the expectation that an inter-racial policy of admission would be allowed to proceed to the point when the numbers of the respective races would approximate to equality, and still less to the stage where the African element will exceed the European". Dr. Kerr therefore favours the immediate foundation, independently of the proposals for the institution of the Rhodesian University, of a university college for African higher education at Lusaka in Northern Rhodesia.

Since the Carr-Saunders report was published in May, the inaugural board of the Rhodesian University has declared that its University would be inter-racial and that admission will be solely dependent on educational attainments and the good character of students. The inaugural board, however, considers that the site of 250 acres already acquired within the city of Salisbury is a good one, and it doubts whether an alternative area of 1,250 acres could be found near Salisbury, and whether a modern university could afford to place itself far from existing centres of civilization. The Board is reported to have said that "to start afresh on a new site and with an entirely new Charter would be needlessly to torpedo all that has been built up".

The Carr-Saunders report is explicit on the need for a site other than that of 250 acres already acquired for the Rhodesian University. This site is in a built-up European residential area of Salisbury, and

even if it were large enough for the first stage in the history of a college, it allows no room for the expansion which will undoubtedly be needed by, say, fifty years hence. Furthermore, "An inter-racial institution would be an experiment in Central Africa, and to try it out in a European residential area would not give it the best chance of success".

Also, the statutory dependence of the Rhodesian University on the Southern Rhodesian Government (even if in time this dependence passes to the Federal Government) is not compatible with the absolute autonomy regarded by the report as essential.

The Carr-Saunders report recommends that a capital sum of £1¼ million should be acquired for the institution of the proposed university college, and that application should be made to the Colonial Development and Welfare Fund for this sum. The report, as Lord Hemingford said in a recent article in *The Times Educational Supplement*, is a challenge to the United Kingdom. The acceptance of this challenge would mean that H.M. Government would at once make clear its willingness to provide this capital sum. Indeed, the suggestion has been made that the British Government might go farther than the Commission's proposals and not only set the college going but also endow it during a preliminary stage of complete independence. It has been estimated that this would cost £5 million.

It will be disastrous for capital and energy to be dissipated in Central Africa by an attempt to found two separate universities. It would be equally undesirable that the Rhodesian University should curtail in advance its hopes of expansion because of an insufficiency of both land and capital finance. A firm statement now by the British Government of the conditions under which it would provide financial support for a university college in Central Africa would clarify the position at once for all concerned, and particularly for the sponsors of the Rhodesian University scheme, who might consider associating themselves with the far more ambitious plan put forward in the Carr-Saunders report.

It is only too easy for the British Government to find reasons for procrastination under present conditions. It is perhaps unfortunate that one of the territories concerned, namely, Southern Rhodesia, a self-governing colony, is administratively associated with the Commonwealth Relations Office in London, whereas Northern Rhodesia and Nyasaland—both protectorates—come under the Colonial Office; it is not difficult to see that these two Government offices may fail to come to agreement concerning responsibility for a capital grant. Moreover, the Carr-Saunders Commission reported to the Central African Council and not to the British Government. However, there should be no insuperable difficulty in preparing a joint statement on behalf of the Commonwealth Relations Office and the Colonial Office. If this can happen—and happen quickly—it can do more than anything else to ensure the success of a great educational step forward in Central Africa, and to make clear to indigenous peoples in those territories that partnership in one important sphere of civilized existence is soon to become a reality.

JORDAN'S COSMOLOGY

Schwerkraft und Weltall

Grundlagen der theoretischen Kosmologie. Von Pascual Jordan. (Die Wissenschaft, Band 107.) Pp. viii+207. (Braunschweig: Friedr. Vieweg und Sohn, 1952.) 15.80 D. marks.

PROF. PASCUAL JORDAN collaborated with Profs. M. Born and W. Heisenberg in the invention of matrix mechanics; then he became noted for his work on unified field theories, and more recently he has been one of the first to introduce the notion of continuing creation into present-day cosmological theory. The many to whom his name has thus become familiar are bound to be interested to know what his new book is about.

Its subject is described in the sub-title as the "foundations of theoretical cosmology". But it is divided into Book 1 on the Riemann–Einstein theory and Book 2 on extended gravitational theory; there really are two books.

The first is a self-contained account of Riemannian geometry and general relativity. Prof. Jordan has bestowed great care upon its preparation, and he now hopes that it will serve as an introductory text for students. I think it has much to recommend it in this character and that it will convey a lively appreciation of the mathematical form and physical concepts of relativity theory. Some of the incidental features are of special interest, although their brevity leaves them somewhat inconclusive. Instances are § 18 on relativistic causality and some remarks in § 20 on Newtonian analogies (certain of which, however, I should regard as rather misleading).

The second 'book' is a presentation of Jordan's ideas on cosmology. There are several notions that have come to exercise a strong appeal to his mind. The first is that of the method of projective relativity; the second is that of the possible variability of the gravitational constant. This possibility was once briefly suggested and later discarded by Dirac; but it seems that Jordan found the original arguments more convincing than Dirac did, both on their own merits and also because their result corresponds to an apparently natural generalization in the mathematics of projective relativity. The third notion is that of the continual entry into the universe of fresh matter in the form of embryonic stars. This appeals to Jordan because he claims to relate it to an upper bound of possible stellar masses and to certain features of super-novæ. But also, if I have not misunderstood him, certain rather unsatisfactory quantitative features of cosmical models derived from his other ideas are in his opinion due to these being models of a smoothed-out universe. Evidently he regards his process of star-genesis as arising from his theory when this simplification is removed. However, he does not give a mathematical treatment of this process itself or show its mathematical connexion with the rest of the work (apart from presenting certain arguments that he thinks may make it mathematically plausible).

Prof. Jordan has already given some account of these ideas[1], and in his book he seeks to give them fresh coherence, though, as I have said, he does not succeed in finding a mathematical treatment that embraces them all; and he surveys astrophysical and geophysical evidence that he regards as favourable to them. Also, he seeks to meet certain criticisms, some of which are rather recondite. Actually, his ideas are

vulnerable to much simpler objections; these have recently been summarized by H. Bondi[2].

Prof. Jordan has earned recognition as a pioneer in questioning previously accepted interpretations of the conservation laws of physics; but, so far as his specific suggestions are concerned, even the most sympathetic reader will recoil from the thought of the particular cosmic phenomena he mentions being manifestations of processes so utterly different from those required to account for apparently closely allied phenomena. If the reader is an astrophysicist he will know that these particular phenomena are in any event well on the way to explanation by current astrophysical theory.

It is the case that the subsequent but independent work of Bondi and T. Gold and of F. Hoyle also started from a reconsideration of conservation laws and also requires the notion of continuing creation. But the existence of these common features tends to be deceptive, rather than otherwise, in considering the respective contributions to cosmological thought. The merits of Jordan's suggestions can be judged on their own, but only after he has taken the trouble to explore their potentialities, as he has done in this book. While Jordan himself presents the work as a preliminary account of something worthy of further pursuit, the reader will almost certainly get the impression that the author is now fighting a rearguard action.

W. H. McCrea

[1] *Nature*, **164**, 637 (1949).
[2] "Cosmology", 163 (1952).

MANUAL OF PAPER CHROMATOGRAPHY

Paper Chromatography

A Laboratory Manual. By Richard J. Block, Raymond LeStrange and Gunter Zweig. Pp. x+195. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 4.50 dollars.

PAPER chromatography is now a standard technique in the laboratories of biologists, biochemists and chemists, and its considerable importance has been recognized by publication of two previous monographs[1,2] on the subject. This volume differs from its predecessors in being a laboratory manual, and as such it is a very welcome addition to the group.

The manual contains chapters on theory, general methods and quantitative methods, followed by chapters on applications in each of the major fields of biochemistry. The chapter on theory is very brief, as might be expected in a laboratory manual, and that on general methods is rather scrappily presented. The later chapters provide a fund of detailed information on specific applications with many comprehensive tables of R_F values. Much of this material is presented in a manner which makes reference to the original literature unnecessary. This is a valuable feature, as the original literature is so scattered.

Though the book contains a valuable fund of information, its presentation leaves something to be desired. The publishers claim, on the dust cover of the book, that its purpose is "the discussion and evaluation of the more important techniques developed in paper chromatography"; the most serious criticism of the book is that such discussion and evaluation are so frequently lacking. Though twenty-two solvents for the separation of amino-acids are described, their relative merits are not discussed; and, though five different methods of preparation of the ninhydrin reagent are given, the need for such variation is not mentioned. This lack of the critical approach may be bound up with the format of the book. The chapters are divided by very numerous and sometimes systematic subheadings. A fair degree of subdivision is essential in a book of this kind to assist in rapid location of specific information, and this is a useful aspect of the later chapters, but the method is here taken to excess and often leads to cumbersome treatment. A more discursive approach would frequently yield a more critical and informative text.

The manual covers the field of paper chromatography very comprehensively, but there are some unfortunate omissions. Most of the later sections of the book are well endowed with tables of R_F values; but those in the sections on amino-acids and sugars seem inadequate. Of twenty-two solvents described for the separation of amino-acids, R_F values are given for only three. It is a pity that there is no mention of partition chromatography in columns, which is such a useful adjunct to paper chromatography, especially where one is concerned with isolation or quantitative estimation of substances. There is also little mention of the valuable work on separation of peptides, or the fruitful marriage between paper chromatography and the isotopic tracer technique. There is a brief description of paper electrophoresis.

The book contains many useful illustrations, but Figs. 1 and 2 of Chapter 12 appear to have been interchanged, and the value of the two colour plates would be increased by fuller description of their contents. In association with Plate 1, a map of two-dimensional separation of amino-acids would be a useful addition. The apparatus illustrated in Figs. 5 and 6 of Chapter 3 could have been ascribed to Dent and co-workers, who first devised them[3,4].

In spite of these criticisms, which it is hoped will be taken in a constructive sense, the book will be of great value to anyone working in this field.

G. Leaf

[1] Cramer, F., "Papierchromatographie" (1953).
[2] Balston, J. N., and Talbot, B. E., "A Guide to Filter Paper and Cellulose Powder Chromatography" (London and Maidstone, 1952).
[3] Dent, C. E., *Biochem. J.*, **43**, 169 (1948).
[4] Dent, C. E., Datta, S., and Harris, H., *Biochem. J.*, **46**, xlii (1950).

INTRODUCTION TO HUMAN PHYSIOLOGY

The Living Body

A Text in Human Physiology. By Prof. Charles Herbert Best and Prof. Norman Burke Taylor. Third edition. Pp. viii+792+16 plates. (New York: Henry Holt and Co.; London: Chapman and Hall, Ltd., 1952.) 37*s*. 6*d*. net.

THIS is an excellent book which could be used as an introduction to the subject of physiology by any type of student, and, after having mastered its contents, the larger kind of handbook should not be so overwhelming as it is sometimes said to be. The only objection to it appears to be in the nature of the first chapter, which gives a précis of the science of chemistry.

Now it is a truism that the start of any book is one of the most difficult of the hurdles which an author encounters on his course, and the awkward-

ness of the start is enhanced when, as in the present instance, the book is itself an introduction to a complex subject. But it does not help a beginner if the first chapter is of the nature of a summary which is either superfluous or indigestible. If the beginner in physiology has no previous knowledge of chemistry, physics and biology, he had far better acquire some, because these disciplines provide tools and concepts without which modern physiology cannot be taught or understood. If the student has such background, then this introductory chapter is unnecessary and distracts from the main thread of the book.

But, apart from this quite minor objection—and it is a minor one because certainly few students are likely to use the chapter—the treatment goes along smoothly and competently. The contents of Chapter 2, which is a brief account of histology, are harmless enough but scarcely necessary if the student has done any general biology. The book seriously settles down to its real business with Chapter 3, on the blood, tissue fluids, etc., and there is no hitch in the story after that. It is clearly and accurately told, and with a modern point of view; the figures are numerous and clear; and stress is laid on aspects of the subject which are of practical importance, such as artificial respiration, shock, blood transfusion, and so on.

One of the difficulties in teaching physiology is that the body works as an integrated whole in which there is complex and continuous interplay between various component parts. Hence the orthodox treatment of the organism by systems is necessarily artificial. The control of function by the central nervous system, by the endocrine organs, and by collaboration between the two is most difficult to bring home at a first presentation. The present authors have tried to bring things together by cross-references as, for example, when dealing with the cardiac nerves by referring to chapters on the central nervous system farther on in the book. This is one way out of the difficulty, but in the end the only way seems to be for the student to read a physiology book twice or, better still, if he is intending to tackle the subject seriously, to read and digest such a book as this and then to pass on, with no terrors, to a more advanced book. In giving a clearly written and accurate book of an introductory kind, the authors have rendered real service to the teacher of physiology.

C. Lovatt Evans

ANALYSIS OF PERSONALITY

The Scientific Study of Personality

By Dr. H. J. Eysenck. Pp. xiii+320. (London: Routledge and Kegan Paul, Ltd., 1952.) 30*s*. net.

THE extensive literature of experimental and speculative work on the topic of personality has indicated that the explanations of a person's behaviour present a particularly complex and intriguing problem. Both from an empirical and a methodological point of view, it is one of the most difficult problems ever to challenge scientific curiosity. The number of possible causes contributing to behaviour is large and varied and may involve reference to fields usually regarded as the province of the economist, historian, anthropologist, physiologist, neurologist, endocrinologist and geneticist. The problem is rendered even more difficult by the operation of the large number of offsetting influences which the individual encounters during his life; and the awkward fact for the exponent of correlational techniques is that experienced clinicians can disagree on the classification of the major abnormal states. Again, while reliable class differences may be established between normals, schizophrenics and psychotics in the performance of a particular task, the clinician is expected to understand the context of each patient's difficulties so that his recommendations as to therapy can be effective within their particular environment.

Dr. H. J. Eysenck begins by warning his reader against the 'prestige' value of the words 'science' and 'scientific' which may cloak questionable procedures; and then indicates that the scientific way of studying personality is to establish principles of classification by the methods of factorial analysis of correlations between the results of a variety of objective tests of behaviour. Although the suggestion of an *argumentum ad verecundiam* by appeal to the prestige of the methods vindicated in the physical sciences does arise, the operational definition of abnormal mental states by reference to the dimensions established by factorial analysis is lucidly presented. The author and his co-workers have undertaken a considerable amount of statistical labour, and some arresting correlations between test performance and clinical designations are reported. Although the discussion of these findings with reference to earlier work is not always marked by customary scientific humility, comparison with results based upon other populations will be awaited with interest.

The work is a competent exposition of techniques whereby tests indicative of abnormal states may be assessed and refined—an important and useful part of the objective approach in a difficult field. The problem as a whole, however, must surely involve a thorough analysis of environmental conditions associated with abnormal states and some indications as to therapy.

F. V. S.

MODULATION THEORY IN RADIO COMMUNICATION

Harmonics, Sidebands and Transients in Communication Engineering

As Studied by the Fourier and Laplace Analyses. By C. Louis Cuccia. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. ix+465. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 76*s*. 6*d*.

THE need to increase the speed of radio communication, to provide a wide range of services and to use the available frequency spectrum in the most economical manner has led to the use of complex systems of modulation, and associated mathematical problems of corresponding complexity have arisen. For example, there is often considerable difficulty in the theoretical evaluation of the band-widths required for the transmission of certain types of signal and in the determination of the response of circuits to applied voltages. The object of Mr. C. L. Cuccia's book is to show how the Fourier series and the Fourier and Laplace transforms can be used for the solution of these and other similar problems. It is essentially a text-book on these functions and is designed particularly for the postgraduate student.

The first four chapters consist of a brief presentation of the Fourier and Laplace methods of analysis—perhaps too brief for the reader with no previous knowledge of these methods, but nevertheless a clear

summary of those aspects which have direct application to communication problems. The methods are then used in a study of the influence of periodic and transient signals on various types of circuit, ranging from simple linear networks to multi-stage amplifiers. The band spectra involved in the different types of modulation are then discussed, and the same analytical methods are applied to the study of travelling waves.

The emphasis throughout is on the development of the mathematical methods, and the book is recommended to students wishing to acquire facility with these methods. Brief descriptions of practical techniques, circuits and devices are given, but are no fuller than is necessary to provide the physical background for the mathematical analysis. The problems discussed are those which occur in modern radio practice, and many of them, relating to television, transistors, cavity magnetrons and klystrons, for example, are of recent origin. The presentation is clear and errors few. Each chapter contains exercises for the student, and there are many references, nearly all to American publications.

As radio communication develops, it becomes increasingly necessary for engineers to become familiar with the more advanced mathematical methods. Mr. Cuccia's book is a valuable guide to the use of some powerful analytical tools; but it appears that even these have their limitations, and there are many problems in the solution of which an ounce of experiment is still worth a ton of mathematics.

F. Horner

THE CESTODES

The Zoology of Tapeworms

By Robert A. Wardle and James Archie McLeod. Pp. xxiv+780. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1952.) 80*s*. net.

THIS encyclopædic work on cestodes, comprised within 780 pages, including the index and a bibliography of 105 pages with nearly three thousand references, is a comprehensive study of the tapeworms known throughout the world. It attempts to summarize what is known about their classification, structure, life-histories and ways of life; it discusses theories of origin and evolution; and it provides detailed, systematic descriptions and keys for the identification of all the known families and genera and most of the known species.

Part 1, the first 169 pages, consists of five chapters. The first deals with the general features of cestodes, including information about the 'holdfast organ', a term preferred by the authors to the more conventional 'scolex', the body, skin, parenchyma, musculature, and the osmoregulatory, nervous, and male and female reproductive systems. Chapter 2 discusses the cestode life-cycle. Our knowledge of the development and life-cycle of tapeworms has accumulated more slowly than that of their general anatomy, and few tapeworm life-cycles are known completely. What information, however, is available is presented in a coherent account. Tapeworm biology is discussed in Chapter 3 from two aspects, that concerning the animal as an individual (its growth, activities, alimentation, respiration and so forth) and that concerning the animal as a member of a partnership (its relationships with other parasites and with its host, and its effects upon the host and those the host may have upon it). In Chapter 4 the various hypotheses, which are purely conjectural, as to the origin and evolution of tapeworms are given, and in Chapter 5 there is an interesting account of the history and classification of cestodes.

Part 2, the bulk of the volume, begins on p. 173 with the classification used by the authors in their book. It is of interest, to systematists at least, to note that the class Cestoda is composed of eleven orders, of which five are new, and the class Cestodaria of three orders, of which one is new. In the ensuing pages these orders are discussed, and for each there is a description, a historical review, the recognition features, and the classification of the order into families, sometimes sub-families, and genera. In the notes on each genus, mention is made of species-groups and of species, and those forms which cannot be fitted within the order or family are dealt with under the heading "Genera Inquirenda". It is difficult, within the compass of a review, to summarize the many interesting and important points raised in this part of the book, and two examples must suffice. Readers will look in vain for *Tænia saginata* and *Tænia tæniæformis*, for they are given respectively as *Tæniarhynchus saginatus* and *Hydatigera tæniæformis*. Regarding the second species, the authors mention that the establishment of genera, indistinguishable as adults, upon features of the larval stages has much to commend it, although there is much to be said against it too. Recognition of the tæniid genera *Echinococcus*, *Hydatigera*, *Multiceps* and *Tænia* on such grounds has long been the practice among American parasitologists; but this very practice opens up the question whether, in the absence of any practicable method of counting chromosomes, the specific and generic units of zoological classification shall be based upon readily recognizable characters of the adult animal, or upon features of the life-cycle and biology, a procedure which, while eminently desirable, is rarely attainable. Without taking sides in the argument, the authors have, in this matter, followed the current American practice.

The authors have undertaken an enormous task, and the result is an important and valuable contribution to zoological literature. They observe that the keys to an understanding of many obscure biological phenomena may be within these animals; but the investigator is baffled by the fragility of his material, by its brief existence when removed from its normal habitat, and by the complexity of its environmental requirements. Nevertheless, a vast literature, polylingual, scattered and fragmentary, has accumulated around them, and the authors' aim has been to present from this literature and from their own observations a coherent story of these helminths and to expose the gaps and imperfections in our knowledge of them; in this they have succeeded remarkably well. The book deserves close and attentive study, for in it are raised problems which provide a challenge and an inspiration to research. It is scarcely a text-book for the undergraduate, but a work of reference for parasitologists, zoologists and workers in various fields of biology. There will be many occasions when it will be consulted by teachers and research workers. The 419 text-illustrations—mostly line-drawings—are well chosen and uniformly good, the text is concise, up to date and lucid, and the printing and binding are all that could be desired.

J. N. Oldham

Foundations of Analysis

The Arithmetic of Whole, Rational, Irrational and Complex Numbers; a Supplement to Text-Books on the Differential and Integral Calculus. By Edmund Landau. Translated by F. Steinhard. Pp. xiv+134. (New York: Chelsea Publishing Co., 1951.) 3.25 dollars.

THE late Prof. E. Landau, of Berlin, was shocked to find that his daughters, who were taking a university course in chemistry and had learned calculus at school, yet did not know why xy was equal to yx. He accepted the fact that a rigorous treatment of algebra was too advanced for schools. He then examined the teaching in universities and found that they apparently often ignored the subject as being too elementary. He could not find a single text-book which dealt satisfactorily with the number system. The only thing left for him was to write such a book himself, and this he did in 1929. After a long delay, an English translation has now appeared.

Everything is based upon five axioms, due to Peano, concerning the natural numbers. The fifth of these asserts the principle of mathematical induction, which is used extensively in what follows. On this basis are established successively in five chapters the ordinary rules for the treatment of natural numbers, fractions, cuts, real numbers and complex numbers. The book is a model of elegance, precision and completeness. The author was perhaps over-optimistic in hoping that a normal student could read through it in two days. It is true that most of the proofs are very simple; but in Britain, at any rate, a normal student will be puzzled by the first words (p. 1): "We assume the following to be given: A set (i.e. totality) of objects called natural numbers, possessing the properties—called axioms—to be listed below". To appreciate this, a preliminary discussion of the nature of 'axioms', of the object of setting up axiomatic systems, and of the relation of such systems to ordinary computations and to physical science would have been helpful. On p. 43 the concise and abstract treatment of cuts may puzzle those who have not previously had a more elementary and concrete exposition of the idea. However, the book is so very good, as a whole, that it would be ungrateful to lay stress on the few points in which it might have been even better.

H. T. H. PIAGGIO

Papierchromatographie

Von Dr. Friedrich Cramer. (Monographien zu Angewandte Chemie und Chemie-Ingenieur-Technik, Nr. 64.) Zweite, neubearbeitete und erweiterte Auflage. Pp. 136. (Weinheim/Bergstr.: Verlag Chemie, GmbH, 1953.) 12.80 D. marks.

THIS revised edition of "Papierchromatographie" gives an excellent account of the literature up to the middle of 1952. It deals with apparatus, preparation and purification of solvents, and with both qualitative and quantitative analysis. All the variants of paper chromatography are included, the chromatopile, reversed-phase chromatograms, alumina and silica-gel treated papers, and papers containing free carboxyl groups. The analysis of amino-acids, sugars, purines, nucleotides, nucleosides and nucleic acids and of inorganic ions are dealt with in some detail. Alcohols, phosphoric esters, phenols, organic acids and bases, vitamins, antibiotics, porphyrins, sterols and synthetic dyestuffs are not considered at such length.

The arrangement of the book is pleasing and the diagrams and colour prints of chromatograms are clear and well presented. The comprehensive lists of R_F values provided are useful, as is the transparent scale for the direct measurement of R_F values on the chromatogram. The transparent map of amino-acid spots from a two-dimensional chromatogram is of restricted usefulness, as it does not cover all the amino-acids normally encountered. Though it is perhaps a pity that the detection and elimination of faults in chromatograms are not dealt with at sufficient length (a common fault of books on this subject), the book can be recommended to all those using the technique of paper chromatography.

Through Movement to Life

The Economic Employment of the Disabled. By John Arthur. Pp. 93+6 plates. (London: Chapman and Hall, Ltd., 1952.) 7*s*. 6*d*. net.

A PROBLEM which causes great concern to employers and all who have social consciences—these two groups are not necessarily exclusive—is the employment of disabled people. In the United Kingdom there are tens of thousands of such unfortunates, including those who have lost a limb, epileptics, spastics, people suffering from rheumatism and arthritis, the deaf and the blind. Most of them are anxious to work, if only to maintain self-respect, and a nation needing labour should be able to make use of their services. In this little book, Mr. John Arthur describes an enterprise which he organized to show how the disabled could work for their own and the community's interests. The enterprise was a furniture factory which was 'sheltered' in the sense that the disabled employees did not have to compete with able-bodied workers and that the factory was not run primarily for profit. Although the venture lasted no more than three years, during that time Mr. Arthur, as managing director, learned a great deal about the means of helping the disabled. This he has set down in a book which is not always free from the ills attending enthusiasm, but which will be of value to all engaged on similar ventures.

T. H. HAWKINS

The Genetics of Garden Plants

By M. B. Crane and W. J. C. Lawrence. Fourth edition. Pp. xvii+301. (London: Macmillan and Co., Ltd., 1952.) 20*s*. net.

THE fourth edition of this popular book, first published in 1934, is said to be amended and revised in accordance with recent research. The brief account of heterosis has been amplified and enlarged in a new Chapter 8 of ten pages, though the exposition of this still mysterious phenomenon follows a stereotyped pattern common to a large number of text-books and fails to mention the now widely current theory that heterosis is mainly due to the advantage of heterozygous phases of growth genes over the homozygous phases.

One gets the impression that the authors are now largely resting on their oars. The last edition was published in 1947, and in spite of the great progress which has been made during the past five years it is disappointing to find reference to eight publications only since that year. Some of these are of minor value, and others lack relevancy to the present state of our knowledge.

The book will no doubt continue to be largely read by horticulturists, and in spite of some obvious omissions it is both useful and valuable to have so much otherwise inaccessible material brought together between two covers.

S. C. HARLAND

ELECTRICAL INSULATING MATERIALS

A SYMPOSIUM on the subject of electrical insulation, held at the Institution of Electrical Engineers during March 16–18, provided a very interesting picture of the vast amount of research work that has been, and is being, done on this subject throughout Great Britain in all the laboratories associated in one way or another with the electrical industry. It is generally realized in the industry that the limitations of existing insulating materials constitute a formidable barrier to progress in many of its branches: voltage-gradients and working temperatures must always be kept well below the limits at which the risk of breakdown becomes appreciable, and great elaboration of design is sometimes necessary to ensure that the essential characteristics of the dielectrics employed are not adversely affected by temperature and humidity. Engineers are therefore continually investigating the processes involved in the normal operation of dielectrics and those in which breakdown occurs; they are no less concerned with the possibilities of new materials and methods of estimating their efficacy and durability under service conditions. Some thirty-two original investigations covering all these aspects of the problem came under review during the five sessions of the symposium. Consideration of the details is not possible in a short article; but a few of the points of more general scientific interest will give some idea of the present position in this field of work.

Permittivity and Power Loss

The first topic considered was the nature of the processes involved in the normal operation of insulating materials of the types used in industry: that is to say, the processes characterized by permittivity (or dielectric constant) and loss angle, the phase difference between the electric displacement within the material and the applied electric field that produces it. The importance of these quantities to the electrical engineer lies in the part that they play in determining the voltage distribution (within an insulating system), the corresponding current distribution, the precise relation between these two distributions (that is to say, the impedance, phase angle and power factor of the system) and also the temperature distribution in the state of thermal equilibrium attained under normal working conditions. The voltage-gradients and impedances (or the corresponding admittances and capacitances) are, of course, almost completely determined by permittivity alone, but the loss angle, although negligibly small for the best dielectrics, is the dominant factor in determining the power dissipated within the material and is therefore of great importance in connexion with thermal equilibrium. The product of permittivity and loss angle, or strictly speaking its tangent, is proportional to the energy dissipated within the specified material during each cycle of the applied voltage. Even the smallest loss angles therefore tend to become significant when the number of cycles per second is of the order of, say, 10^{10}, which is about the upper limit of the electrical range of frequencies—the centimetre and millimetre waves. In this region, electrical and optical techniques merge into one another, and it was appropriate therefore that, in one paper, Dr. W. Culshaw (Telecommunications Research Establishment) described a spectrometer method by which permittivity and loss angle can be measured for flat sheet material traversed by millimetre waves. The method has been shown to be practicable but has not yet yielded data beyond the reach of the established electrical methods which were employed by the other contributors—bridge methods for the lowest frequencies, circuit-resonance methods for the main radio range, and cavity resonators for centimetre waves.

The data for most of the materials of interest to engineers are of great complexity, and we are still far from a full understanding of the processes involved. The main characteristics of the simplest ones are, of course, well known. Part of the electric displacement is always such as can be visualized as a displacement of the electrons with respect to the atomic nuclei, a process having a natural frequency in the optical range and capable of accounting for the optical index of refraction of the material. If no additional process occurred at electrical frequencies, the dielectric constant would be equal to the square of the optical refractive index and the loss angle would be zero, since this fast displacement follows the slow electrical cycles with no appreciable lag. This condition was shown by Dr. L. Hartshorn, J. V. L. Parry and E. Rushton (National Physical Laboratory) to hold remarkably closely for the pure hydrocarbon plastics and the fluorocarbon polytetrafluorethylene. Any loss angle observed in such materials in practice can only arise from accidental impurities. The permittivity of such materials is independent of frequency but diminishes with rise of temperature by an amount corresponding with the linear expansion of the material.

Most other materials show a permittivity considerably greater than the square of the optical refractive index and therefore call for a consideration of two other displacement processes. The first is the displacement of different atomic nuclei with respect to one another, a process which may be expected to have a natural frequency in the infra-red region—that is to say, still far enough above the electrical frequencies to give rise to no appreciable loss angle in electrical work. The second additional displacement is that arising from changes in the orientation of molecules or groups of atoms having a permanent dipole moment, changes which are characterized by a time-constant or time of relaxation rather than a frequency of vibration. The extent to which this displacement occurs, during each half-cycle of the applied field, depends on the relative values of the time constant and the duration of the half-cycle; but at frequencies for which the two are of the same order, the permittivity increases rapidly as the frequency falls and so gives the dipole orientation appreciably more time to develop, while at the same time the loss angle rises to a maximum value, which again diminishes to zero when the cycle becomes so slow that the dipole orientation follows the field without appreciable lag. The relaxation time is strongly dependent on temperature, and therefore both permittivity and loss angle are liable to vary greatly with temperature as well as frequency, and

there is a necessary connexion between the variation of the two quantities. A paper by A. C. Lynch (Post Office Research Station, Dollis Hill) discussed this question in its bearing on the temperature coefficient of mica capacitors, emphasizing that the temperature coefficient for radio uses is liable to be quite different from that for low frequencies. The time constants of the electric displacements within the material may not in this instance arise from dipolar molecules; they may arise from differences in the distribution of resistivity and permittivity in a composite dielectric in accordance with classical theory as developed by Maxwell, but since such time constants are also temperature-dependent the same considerations apply. Dr. A. Fairweather and E. J. Frost, also of Dollis Hill, applied this simple theory to semi-conducting aggregates such as the ferrites, used primarily for their magnetic properties, though their dielectric properties are not without some influence on their performance in communication circuits. The dielectric properties, though complicated, were shown to be adequately accounted for by a network of capacitors and resistors each corresponding to some simple recognizable feature of the composite material.

Hartshorn, Parry and Rushton were particularly concerned with the dipolar process in the silicones and in representative plastics. All the long-chain silicones show a peak in the curve for loss angle at frequencies between 10^{10} and 10^{11} c./s., and it is inferred that the corresponding relaxation time, which is independent of chain-length, is characteristic of the Si—O linkage in flexible linear chains. The permittivity and loss angle of the water-absorbent plastics have been shown to be very largely dominated by the absorbed water; but it is striking that the values for the completely dried materials, though smaller, are of the same general character as those for which the water is responsible. In other words, the absorbed water molecules behave in the electric field almost exactly like the polar groups in the structure of the pure resin, and not like free water. The main features of the observed properties are found to correspond well with a model given by Fröhlich as an extension of Debye's theory.

A. Turney (Imperial College of Science and Technology, London) reported an attempt to find evidence for a resonance process suggested by Fröhlich as also associated with the dipoles, by examining benzene derivatives having a structure considered to be most favourable for such a process; but the evidence was negative, the above-mentioned model accounting for all the observations.

Liquids

A session devoted to liquids brought out the fact that in British electrical practice the one liquid that is of supreme importance is mineral oil, transformer oil and the like. Broadly speaking, it can be regarded as a paraffin oil, initially pure but subject to contamination in use. Its primary function is to exclude moisture and air from solid insulation, usually cellulose in the form of paper or pressboard, which supplies the required mechanical properties, but only behaves as a good dielectric so long as moisture or damp air are denied access to it. The papers and discussion clearly reflected the great importance in heavy electrical engineering of the paper and oil combination, and the effect on it of moisture and other contaminants. J. Dunkley and Dr. R. W. Sillars (Metropolitan Vickers Electrical Co., Ltd.) showed that, when the oil is very highly refined, far beyond the ordinary commercial limit, it shows no measurable loss angle even when damp air is blown through it. If, however, it contains a trace of an ester, which itself produces no loss angle at low frequencies, it develops a comparatively large loss angle when allowed access to damp air. The power loss is shown to be associated with ionic conduction; the conductivity varies with the applied field because of the effect of the field on the balance between the dissociation and recombination of ions, and with the frequency because the relaxation time of this process is comparable with the periodic time of the applied voltage.

In practice the oil commonly rises in temperature to a value near 100° C., one of its functions being to promote cooling by convection, and the high temperature with some access to air introduces further complications of great practical importance. K. H. Stark reported an investigation carried out by the Electrical Research Association into the behaviour of ordinary oil under these conditions. The oil, when at 20° C. or thereabouts, normally has a power factor, probably due to traces of some ionized constituent, that is very small, but accurately measurable provided the greatest possible care is taken to ensure that the capacitor in which the oil is tested is chemically clean. R. G. Martin and E. A. Patterson (Shell Petroleum Co., Ltd.) showed that the capacitor must be dismantled and the parts boiled in trichlorethylene before each test in order to ensure that the values are truly representative of the oil. Even when this is done, no unique value is obtainable for a sample of oil at 100° C. Oxidation of the oil occurs, and Mr. Stark showed that its effect on the loss angle is a rapid diminution, which is followed by an increase. The action is accelerated by the presence of metal in the oil, probably by catalytic action at the metal surface. The quality of an oil cannot therefore be assessed by any single measurement at the working temperature.

In practice the slow continued oxidation leads to the development of acidity and conductivity in the oil, the formation of sludge, an increase in the power factor of the paper–oil mixture, and a consequent reduction of the voltage at which thermal instability would occur. Rusting of metallic iron in the system also occurs, and some of the iron compounds formed may go into solution; others may merely add to the sludge, which may ultimately become harmful by impeding the convection cooling action, but does not necessarily affect the dielectric properties to a serious extent. D. G. Childs and A. W. Stannet (British Electricity Authority) reported some interesting observations on oils that had actually been in service in various localities for periods ranging from one to twenty-four years. Simple tests of acidity and conductivity were used as an indication of condition, but conductivity did not show good correlation with acidity alone. Variations in iron content had a marked effect, and must be taken into consideration if acidity is used as a criterion of insulating quality. Their survey indicated an expectation of life of thirty-five years for the oils in general use.

Breakdown

The session devoted to a consideration of electric strength and breakdown mechanisms attracted a very large audience, for the avoidance of breakdown is a vital consideration in every electrical design. The papers, particularly one by H. F. Church and C. G. Garton, of the Electrical Research Association,

emphasized the fact that breakdown such as is liable to occur in practice is a process far more complex than those represented by permittivity and power factor or indeed than any other occurring in electrical equipment. To the casual observer the breakdown is an instantaneous catastrophic collapse of the structure of the material, and the idea that any given material will withstand indefinitely voltage gradients up to a certain critical value, characteristic of its structure and known as its electric strength, arose naturally from the first tentative studies of the phenomenon. It is now abundantly clear that, although it is possible to determine, by voltage applied under highly special conditions, limiting voltage-gradients of this kind which are indeed characteristic of the atomic structure of the materials, yet this intrinsic electric strength is of comparatively minor importance in the much larger question of breakdown under ordinary working conditions. The intrinsic breakdown strengths of all ordinary solid and liquid insulating materials are in the region of a few MV./cm., and they vary comparatively little with temperature and from one material to another, whereas in ordinary practice breakdown commonly occurs at an apparent voltage-gradient which is no more than one-tenth of this value; moreover, the observed value has no clear relation to the structure of the material and is greatly influenced by many other variables such as temperature, duration of application of the voltage, etc. The central problem in research on electrical insulation to-day is not so much to increase, or even to explain, intrinsic electric strengths as to raise the applied voltage-gradient at which breakdown occurs under ordinary practical conditions. C. G. Garton made the point that even halving the gap between the intrinsic electric strength and the electric strength as measured under ordinary working conditions would make possible revolutionary improvements in design.

Intrinsic electric strength was, however, not neglected. A paper by J. H. Calderwood, R. Cooper and A. A. Wallace (University of Liverpool) showed that mechanical strain may increase the value for a crystal, so that the highest value obtained for a given sample is not necessarily the true one. Another paper, by Dr. T. J. Lewis (Queen Mary College, London), described a satisfactory technique for obtaining values truly characteristic of pure organic liquids.

Breakdown at the intrinsic electric strength is an electronic process which has been reasonably well explained by the work of Fröhlich and others; breakdown under ordinary working conditions is usually a complex chain of processes, of much longer duration than the intrinsic breakdown, and perhaps including an intrinsic breakdown as part of the chain but sometimes including processes that might be described as chemical rather than electrical. Moreover, it is not a question of a well-defined chain characteristic of a material, but of a number of possible chains, the choice depending on factors the presence of which may not be suspected—for example, the presence of sub-microscopic voids or gaseous inclusions, or ions having particular chemical properties. In this state of extreme complexity, progress is perhaps best made by isolating and studying the component processes separately, and this is what many workers are doing.

For example, papers by Dr. E. Friedlander and J. R. Reed (General Electric Co., Ltd.), by W. L. Harries (University of Oxford) and by J. H. Mason (Electrical Research Association) were all concerned with breakdown processes which include as the dominant feature discharges in a gas enclosed within solid insulating walls. Nearly all industrial materials contain such gaseous inclusions, which may or may not be visible: the voltage-gradient within them tends to be relatively high, and the electric strength of the gas is relatively low, so that discharges occur at moderate overall voltage gradients. Such discharges do not necessarily lead to breakdown of the insulation as a whole; indeed, a speaker claimed that bushings in which discharges had been detected under working voltages had been known to function satisfactorily for twenty years. However, the bombardment of the walls of the enclosure by the ions carrying the discharge may produce actual erosion of the material and a local concentration of field, which may develop progressively until complete breakdown follows. Local concentrations of field within microscopic or smaller regions of the material are probably the key to the whole problem, for, if the local stress rises to the intrinsic electric strength, local breakdown necessarily occurs and there is a probability of it developing progressively or of stimulating some chemical or thermal change which develops progressively under alternating voltage. A paper by H. G. Riddlestone (Electrical Research Association) presented evidence supporting the view that the breakdown of both polythene and polystyrene under A.C. conditions involves the development of intensely local rises of temperature, though the mechanism by which it occurs in such low-loss materials is by no means obvious.

Breakdown by thermal instability is much less surprising in the oil–pressboard combination mentioned in connexion with liquids, for the power factor is greater and its increase with rise of temperature directly measurable. R. T. Rushall (British Thomson-Houston Co., Ltd.) showed that the breakdown voltage, as judged by a straightforward one-minute test, is closely associated with the measured loss factor, irrespective of varying temperature and moisture content. This clearly indicates thermal instability as setting the limit to the safe working voltage-gradient, and moreover provides a method of estimating the risk of breakdown by a measurement of permittivity and power factor at a perfectly safe voltage.

Breakdown by short voltage impulses is usually closely related to the intrinsic electric strength, and Dr. B. Salvage (W. T. Henley's Telegraph Works Co., Ltd.) showed that the observed values for cables are very much what would be expected from the known values of intrinsic electric strength and permittivity of the constituent materials.

New Materials

Comparative studies of new and old materials for specific purposes naturally attracted much attention at the symposium: for example, the various types of impregnating varnish, the newer laminated materials, materials that have been tried in rotating machines and the special ceramics available for radio uses.

In matters of fine detail and on the comparatively small scale, chemical advances have played a prominent part. Consider, for example, the impregnating varnishes; coils wound with cotton-covered wire are impregnated with varnish which is then hardened, this being an economical process for producing a structure that is mechanically rigid and well insulated

throughout, provided the varnish has just the right penetrating, hardening and insulating qualities. R. Newbound and R. T. Rushall (British Thomson-Houston Co., Ltd.) and H. R. Heap (Crompton Parkinson, Ltd.) reported on this matter. It is perhaps not surprising to find that thermo-setting varnishes incorporating phenolic resins tend to provide a better mechanical job than the older oil-oxidizing varnishes, but it would have been difficult to foresee that the use of phenolic varnish would lead to less oxidation and sludge formation when the coils are operated in oil, either by more effective covering of the copper surface, which acts as a catalyst, or by some direct inhibiting action. The difficulties of devising tests for the required combination of qualities are obvious.

On the larger scale the impression left is that chemical advances have not influenced practice so much as might have been expected. Traditional materials like mica, shellac, paper and mineral oil still seem to dominate the whole picture. It is true that polyethylene, polystyrene and the new ceramics have made possible important advances in the radio and radar fields, that glass fabrics, nylon, terylene and the silicones introduce the possibility of improvements in particular directions at a cost which may not be prohibitive, and these and many similar matters received due consideration; but no contributor was found to suggest that any revolution in practice on the large scale is in sight.

Nevertheless, the symposium as a whole gave an encouraging picture of activity and progress on a very wide front; the many widely scattered workers thus brought together for the first time appreciated its stimulating effect, and the industry cannot fail to benefit in due course as the ideas and knowledge assembled become more widely disseminated throughout the main body of its members.

L. Hartshorn

ORGANIC MANURES AND FERTILIZERS

In the Section of Comparative Medicine of the Royal Society of Medicine a discussion was held on May 20 on "Organic Manures and Fertilizers and the Production and Composition of Food for Man and Animals". The president of the Section, Prof. C. L. Oakley, was in the chair and introduced the speakers.

Sir William Ogg (Rothamsted), who opened the discussion, outlined the present position and dealt with the soil aspects of the question. In order to maintain or increase fertility it has, from very early times, been the practice of farmers in most parts of the world to return to the soil, crop residues, animal manure and domestic waste and to rest the land for periods under grass. If production is not too intensive, this system is usually quite successful provided there is not a deficiency of some essential mineral nutrient. With increasing population and its concentration in towns, new problems have arisen. Through modern systems of sanitation, much of the manurial residue which used to find its way back to the land is now carried as sewage to the sea. The introduction of fertilizers just over a century ago enabled farmers to make good these losses and also to increase production. They have not superseded farmyard manure, which, in addition to its manurial value, has important physical effects on the soil; but they are a source of additional plant food and without them the present population of the world could not be fed. It has been estimated that, in terms of readily available nutrients, the total amount of farmyard manure made annually in Great Britain provides only about a third of the nitrogen, a quarter of the phosphate and half the potash applied in the form of fertilizers. Fertilizer consumption has practically trebled in Britain and the United States in the past fifteen years and this has been a major factor in increasing food production.

Attempts have been made to create a controversy over the respective merits of organic manures and fertilizers. The conflict of opinion is, in fact, between those who advocate a proper use of both and a very small minority who oppose the use of fertilizers. It is sometimes alleged that fertilizers poison the soil and are injurious to the health of plants, animals and human beings. There is no sound evidence to support these views, provided that fertilizers are properly used. They do no harm to the earthworms or to the bacteria and other micro-organisms; nor do they bring about soil erosion. There is no evidence that they render plants more liable to suffer from insect, fungus or virus attacks. Organic manures and fertilizers are complementary, and in good farming practice both are employed.

Dr. G. C. Ainsworth (University College, Exeter), as a botanist and microbiologist, directed attention to the complexity of the total situation which determines health and disease in plants and of which the soil–plant interaction is only a part. Green plants are not dependent on the soil for their carbon, but they are for their other nutrients. Under natural conditions, plants die and decay *in situ* and so repay their debt to the soil together with interest in the form of organic matter. On cultivated land, man periodically removes a crop, and this inevitably leads to a depletion of the soil which must be made good. In primitive societies the exhausted soil is abandoned—an impossible procedure in more advanced and densely populated countries, where a balanced use of chemical fertilizers would appear to be the rational and most convenient way of maintaining the nitrogen, phosphorus and potassium, that trinity of elements basic for plant growth. Chemicals, too, are an appropriate source of the small quantities of boron, copper or other 'trace elements' which may render an unsatisfactory soil fertile.

An agricultural soil has not the simplicity of a controlled and mechanically irrigated sand culture. The organic matter it contains has a vital role in conserving moisture and in providing a substrate for the growth of micro-organisms which, in their turn, affect the physical condition of the soil by determining crumb structure and in making available materials which can be utilized by higher plants. At the same time, the microflora competes with the higher plants for nutrients, and certain fungi may cause disease, while another class, the mycorrhizal fungi, set up a symbiotic relationship with higher plants. The use of farmyard manure is the age-old solution to the problem of maintaining both the inorganic and organic constituents of the soil and the microbial population, but the advent of the internal combustion engine has rendered this solution inadequate and new sources of organic manures are having to be explored. Sometimes it is necessary to introduce the requisite symbiont for a particular plant when the plant is grown in a new situation. Finally, the summation of the soil–plant interaction, as manifest

by the response of the plant to the weather and the pathogen, was touched on and the recent work on systemic fungicides and insecticides recalled, for it is possible that plants absorb such substances from the soil.

Dr. David P. Cuthbertson (Rowett Research Institute) dealt with the relationship of manures to the health of man and animals. He pointed out that no amount of composting can return to a farm the products which move out of it in the form of crops and livestock, and that the use of natural organic manures alone cannot supply the trace elements which are deficient over considerable areas of the world. Australian agriculture would largely collapse without fertilizers.

The advocates of organic farming state that the full benefits of composting, the four-year ley and grazing as fertilizing agents are not achieved by orthodox farming, since the manure from livestock fed on concentrates will be deficient in certain essential minerals. There is no evidence to support this generalization, always provided that there is intelligent balancing of fertilizers and farmyard manure, and that the soil is not intrinsically deficient in some minerals.

Regarding the effect on protein and the free amino-acids, there is no evidence that the application of fertilizers has any adverse effect on total amino-acid content. Man consumes a variety of proteins of both vegetable and animal origin and the essential amino-acid requirements are generally met. This may also be said for non-ruminant farm stock; in the case of the bird, special care has to be exercised so that all critical amino-acid requirements are covered. The ruminant is well protected against amino-acid deficiency owing to the microbial activity in the fore-stomach.

The genetic stability of plants is generally of greater significance than climate, soil or fertilizer treatments in respect of vitamin content.

The increased use of fertilizers has not affected adversely the general decline in infant mortality or the increase in the expectation of life of man. The best health conditions which can be observed are compatible with the general consumption of foods grown on chemically manured soil. The health statistics of the Netherlands are as good as those of Great Britain, although the fertilizer consumption of the former is five times the latter per unit of agricultural land. Again, the United Kingdom health statistics are as good as those of Eire, while the corresponding ratio of fertilizer consumption is about 3 to 1.

The belief that the improvement in grassland culture has led to an increase in the so-called metabolic diseases of cattle has not been proved.

Until proof has been obtained that the heavy application of fertilizers may give rise to disease in man or beast, the use of fertilizers as practised in orthodox farming is to be recommended as a means of increasing food production in Great Britain.

Sir James Scott Watson (Ministry of Agriculture) dealt with the maintenance of soil fertility in the future. Our present knowledge is in part the result of farming experience built up over some eight thousand years, and in part the product of scientific investigation during recent times; and Sir James discussed some of the problems of reconciling science and tradition. The list of essential plant nutrients is now probably complete; the chemist can produce a solution of pure salts, in distilled water, that will support normal plant growth, and we have no evidence that the plant products when fed to experimental animals are in any way deficient in nutrient properties. Plant growth, however, depends not only on nutrients but also on a reasonably constant supply of water, and root activity demands a supply of oxygen and is inhibited by a relatively low concentration of carbon dioxide. These requirements imply the maintenance of crumb structure, and loss of this structure is one of the major causes of erosion by wind and water.

The maintenance of good structure depends on several factors. One of these is tillage at the right time when the soil has an appropriate moisture content and when frost and thaw can play their part. Another is the nature of the soil minerals; sandy soils can be improved by applying clay and marl or vice versa. Yet another is the provision of a mild binding agent, and the natural one consists of the colloidal decomposition products of organic matter. The organic matter may be partially decayed as in farmyard manure and composts, or it may be undecayed; and in the latter case the rate of decomposition depends in the main on the ratio of carbon to nitrogen compounds. More research is required on the balance between the grass and clover components of pasture and on management. The practice of growing crops specially for 'green manuring' also deserves further study, and probably the most promising are quick-growing grasses with very heavy seedings and high applications of fertilizers. Sewage sludge, preferably composted with straw, is a useful source of organic matter but is costly to transport and handle. Certain synthetic plastics have recently been shown to be effective in stabilizing an existing crumb structure, but the immediate obstacle to their general use is their high cost.

GEOLOGICAL SURVEY BORING IN GREAT BRITAIN

At a meeting of the Geological Society on July 1, Dr. W. J. Pugh, director of the Geological Survey of Great Britain, gave a brief account of the investigations by boring carried out within the past year by the Geological Survey.

Proposals for a programme of Survey boring were made in 1945 by a Committee of the Advisory Council of the Department of Scientific and Industrial Research; and since then several deep boreholes have been drilled as the work of the field staff and the availability of funds have permitted.

Summary accounts of the results obtained from four of these boreholes, one in Needwood Forest (Staffs), one at Whittington Heath (Staffs)[1], one at Stowell Park (Glos) and one at Rashiehill (Stirling), have been published or are in the press. From four other holes, one of them not yet completed, important information has been obtained; and Dr. Pugh gave an outline of the results so far to hand and referred to the deductions to be drawn from them.

Ashton Park. In the Bristol and Somerset Coalfield the strata between the Carboniferous Limestone Series and the Coal Measures are masked by Triassic deposits at the surface and had not been adequately seen either underground or during boring operations. In order satisfactorily to elucidate the structure of the field, the geological survey of which has been recently completed on the scale of 6 inches to the

mile, it was necessary to prove the thickness and sequence of these strata; and for this purpose a borehole at Ashton Park, Bristol, was started in July 1952 by Messrs. John Thom, Ltd.

The bore reached a depth of 2,195 ft. Triassic rocks, consisting of sandy red marls, were found to a depth of 130 ft. They rest on Coal Measures, 578 ft. thick, in which three coals were encountered, namely, the Ashton Top, the Ashton Great and the Ashton Little seams. Apart from a 20-ft. band of non-marine lamellibranchs above the Ashton Little Seam, the Coal Measures to this depth have proved singularly barren of plant and animal remains. Below the Ashton Little Seam, however, marine strata with *Lingula* were found between 572 ft. 7 in. and 726 ft. 5 in. The Ashton Vale Marine Bed lies between 687 ft. 5 in. and the bottom of the Coal Measures at 708 ft. 2 in. It contains many goniatites, including the characteristic *Gastrioceras subcrenatum*. A Quartzitic Sandstone group of strata extends from the base of the Coal Measures to a depth of 1,315 ft. and consists mainly of hard quartzose sandstones. There are interbedded shales near the top and chert beds, resembling those of Culm type, in the bottom 80 ft. This group probably corresponds roughly to the Millstone Grit of northern England. Below 1,235 ft. sandstones give place downwards into limestones by alternation. Both are considered to belong to the Carboniferous Limestone Series and to represent the uppermost part of the sequence exposed in the Avon Gorge. Below 2,000 ft. the bore passed through the limestones forming the passage between the D_1 and S_2 subzones (in terms of Vaughan's zonal nomenclature).

Upton, Burford. In 1875 a borehole, possibly in search of iron ore, was put down near Burford Signet Farm, Burford, Oxon. It was stated by De Rance to have proved Coal Measures beneath Trias, but published records are inconclusive. The detailed record of a later borehole at Batsford, Glos, about sixteen miles to the north, showed that barren Upper Coal Measures beneath Trias were 524 ft. thick and rested on Silurian rocks. These facts, and the great thickness of Triassic rocks found in the Stowell Park Borehole, some ten miles west of Burford, were the main factors leading to the decision to bore again near Burford.

Drilling was commenced by Messrs. Craelius Co., Ltd., in August 1952. Starting at the base of the Inferior Oolite, the bore proved the Upper and Middle Lias to be thin, whereas the Lower Lias (460 ft.) and the Trias (525 ft.) were of such thickness as had been anticipated.

Upper Coal Measures were entered at 1,105 ft. and were proved to a thickness of 2,664 ft. These non-productive measures are alternating red and grey in colour and contain thin coals. In character they are comparable with parts of the higher Coal Measures sequence in South Staffordshire and with some in the Bristol district. Thin limestones occurred at two levels, the lower containing *Spirorbis*; gastropods were found at both horizons. No plants of age other than Staffordian have yet been detected.

Canvey Island. The possible existence of coal-bearing strata under south Essex has long been discussed, and a view that a basin of such measures lay under the Thames Estuary was advanced following the findings of a gravity survey by the D'Arcy Exploration Co., Ltd.[2], which showed a pronounced gravity 'low' extending beneath the estuary between Canvey Island and the Isle of Grain. Such evidence as was available from other deep bores in neighbouring areas was not wholly favourable to this view, but the gravity anomaly was considered to warrant investigation by boring. Drilling was commenced in January 1953 by the Bremner Well-Drilling Co., Ltd. Coring was started in the Upper Greensand at a depth of 1,200 ft. The underlying Gault extended to 1,320 ft. 6 in. and rested with angular disconformity upon a sandstone-mudstone sequence continuing to the bottom of the hole at 1,750 ft. Fragmentary plant remains and ostracods indicate an age not younger than Middle Devonian and not older than Downtonian.

Cambridge. Seismic reflexion work[3] had indicated the probability that the surface of the Palæozoic strata under the Mesozoic rocks in the Cambridge area was about 360 ft. below O.D., and Prof. W. B. R. King initiated a scheme to investigate this point by boring. The Royal Society and various industrial firms made grants towards the cost of the borehole and ultimately the project was undertaken jointly with the Geological Survey. The site of the bore is near that chosen for the future extension of the geophysical laboratories at Cambridge, and the hole is being kept permanently open to provide opportunity for instruction and research in geophysics in the University.

Boring was commenced in October 1952 by Messrs. George Stow and Co., Ltd. The Palæozoic floor was struck at a depth closely in accordance with the geophysical estimates, but the Carboniferous Limestone of which it consists was not expected. As the Jurassic strata gave promise of valuable information they were cored throughout. The formations proved include Gault to 138 ft. depth, Lower Greensand (31 ft. 6 in.), Corallian Beds (9 ft. 6 in.), Oxford Clay (159 ft. 2 in.), Kellaways Beds (10 ft. 6 in.), ? Upper Cornbrash (7 ft. 10 in.), 'Great Oolite' (4 ft. 3 in.), Upper Estuarine Beds (31 ft. 3 in.) and Lower Lias (41 ft. 3 in.) to 434 ft. depth. This last rests on Carboniferous Limestone which at 590 ft. depth has not yet been bottomed. The limestone, of which 157 ft. has been cored, is highly dolomitic and appears to belong to the lower half of the Carboniferous Limestone Series.

[1] "New Coalfield in Britain", *Nature*, **163**, 831 (1949).
[2] Falcon, N. L., and Tarrant, L. H., *Quart. J. Geol. Soc.*, **106**, 141 (1951).
[3] Bullard, E. C., Gaskell, T. F., Harland, W. B., and Kerr-Grant, C., *Phil. Trans. Roy. Soc.*, A, **239**, 29 (1940).

OBITUARIES

Prof. Samuel Smiles, O.B.E., F.R.S.

Dr. Samuel Smiles, emeritus professor of chemistry in the University of London, died at Tunbridge Wells on May 6 after a short illness. He was born in Belfast on July 17, 1877, the son of Samuel Smiles, of Beckenham, and grandson of the well-known writer of the same name. Educated at Marlborough, he entered University College, London, in 1894, graduated B.Sc. in 1897, and D.Sc. in 1901. His thesis for his doctorate included his early contribution to the stereochemistry of sulphur, published in 1900.

During 1900–2 Prof. Smiles was on the Continent, working with Moissan in Paris and Knorr in Jena. At the commencement of the 1902–3 session he was appointed an assistant in the Department of Chemistry in University College, London, and became assistant professor in 1907, a post he held until 1919, when he was appointed to the chair of organic

chemistry at Armstrong (now King's) College, Newcastle upon Tyne. At Easter 1920, he succeeded the late Prof. Crossley as Daniell professor of chemistry, King's College, London, where he remained until his retirement in 1938.

During the First World War, he was engaged upon problems connected with tracer ammunition, and for these services received the O.B.E. in 1918. In that year also he was elected a Fellow of the Royal Society. He was a Fellow of both University College and King's College, London, and an honorary D.Sc. of Queen's University, Belfast.

Prof. Smiles rendered considerable service to the chartered chemical bodies. A Fellow of the Chemical Society from 1898, he served as secretary during 1912–20, and was a vice-president during 1920–23. He became a Fellow of the Royal Institute of Chemistry in 1916, was examiner in general chemistry for the associateship during 1920–24, and a member of Council during 1931–35 and 1936–39.

In 1920 he married Minnie, youngest daughter of the late G. N. Patterson, of Newcastle, who survives him. During most of the war and post-war period, Prof. and Mrs. Smiles lived at Inverness, but had quite recently returned to Tunbridge Wells, where they had resided during his tenure of the King's College professorship.

Almost all Prof. Smiles's published papers, numbering more than a hundred, are concerned with organic compounds of sulphur (or selenium). The only exceptions are those with Moissan on silicon and silicon hydrides; that with Knorr on β-methylmorphimethine; and his last three papers. His studies touched on many different types of sulphur compounds, including sulphonium bases, sulphoxides, sulphinic and sulphenic acid derivatives and cyclic compounds. Typical investigations were those on disulphoxides, which were shown to be thiolsulphonic esters; and on the two isomeric sulphides of β-naphthol. As early as 1911, he had been interested in the problem presented by the β-naphthol sulphides; with his collaborators he elucidated it in a long series of papers, and showed the interconversion of the two compounds to be a special example of what came to be called 'the Smiles' rearrangement'. His last three papers were concerned with other examples (not sulphur compounds), including aryl salicylates and *o*-carbamyl derivatives of diphenyl ether. Appropriately, all this work was adequately summarized, just after Prof. Smiles's retirement, in the *Annual Report on the Progress of Chemistry* (**36**, 197; 1939).

Except the work published with Moissan in the *Comptes rendus* of the Paris Academy of Sciences and a few papers in the *Berichte*, all Prof. Smiles's papers appeared in the *Journal of the Chemical Society*, its *Proceedings* and *Transactions*. His only published book was "The Relations between Chemical Constitution and some Physical Properties", published in 1910. It was never reprinted and copies are not easy to come by. Although progress both of accumulation of data and of underlying theory has left the book behind, it still has interest as an introduction to its subject.

Valuable as his research work was, it is even more as a teacher that Prof. Smiles will be remembered. In the period 1917–19 at University College, he lectured on systematic inorganic chemistry as well as organic, and at King's College he always maintained the excellent practice of lecturing on inorganic chemistry to the first-year students. He was accustomed to say himself that one of the most difficult tasks of those in academic life was to maintain a proper balance between research and the teaching and training of students. In his later years, he tended to shift the balance towards the teaching side, and indeed to regard research as a part of student training. He came to have a fine reputation as a teacher, and to have been a student under Smiles was a recommendation in itself.

His interest in his students did not stop short with their academic life; he was a kind and wise adviser on their choice of employment, and took a deep and practical interest in their subsequent careers. The affection and esteem in which he was held by his old students and colleagues were evident on his retirement, and are simply expressed by the inscription in the watch which they presented to him in the autumn of 1938: "Samuel Smiles—Teacher and Friend".

Reginald Child

Prof. A. Mittasch

On June 4 last, Prof. Alwin Mittasch died in Heidelberg in his eighty-third year. He started as a chemist, studied the then mysterious phenomenon of catalysis under Ostwald and was later commissioned by Carl Bosch in Ludwigshafen to find a method of putting into commercial production Fritz Haber's experiments on the catalytic formation of ammonia from nitrogen and hydrogen. In this he was fully successful. Later he broadened his studies and thoughts about catalysis so considerably that in 1948 he published a book under the title, "Von der Chemie zur Philosophie". The philosophical aspect of catalysis is release (*Auslösung*)—a relation between cause and effect which does not obey energetic laws, such as, for example, the action of the will. These trains of thought brought Mittasch into contact with Robert Mayer, and he published a great number of essays dealing with Mayer's writings. In the last year of his life Mittasch published two books of considerable importance—"Friedrich Nietzsche als Naturphilosoph" and, quite recently, "Erlösung und Vollendung". Mittasch enjoyed the rather exceptional honour of being made member of the Heidelberg Academy of Science without being a university professor, but, on the occasion of his eightieth birthday, the title professor was awarded to him. Up to his last illness, which led to his death within a few weeks, the old scholar was in the full possession of his mental powers and incessantly busy writing articles and answering, mostly by return mail, the letters of a wide circle of friends which his enthusiastic temperament and his kind nature attracted to him.

Miss Henrietta Jex-Blake

Miss Henrietta Jex-Blake, who died on May 21 at the age of ninety, was principal of Lady Margaret Hall, Oxford, during 1909–21. Her father was Dr. T. W. Jex-Blake, Dean of Wells and formerly headmaster of Rugby. After being headmistress of St. Margaret's, Polmont, from 1889 until 1909 she succeeded Dame Elizabeth Wordsworth, the first principal of the Hall, who had held office for thirty years.

The demand among women for an Oxford education had, throughout the Hall's history, led to a steady expansion in its numbers, and Miss Jex-Blake's term of office coincided with a marked increase in this demand. Under her a considerable building pro-

gramme was carried out, in defiance of shortage of funds, and the Toynbee Building, designed by Sir Reginald Blomfield, was opened in 1914, bringing the accommodation for undergraduates up to eighty. Her principalship covered the difficult years of the First World War, and, following them, the culmination in 1920 of the long struggle for the opening of Oxford degrees to women. Miss Jex-Blake had the satisfaction of receiving the M.A. herself at the first degree ceremony in October 1920, and then of presenting a steady stream of her former students at successive ceremonies until her retirement in 1921.

In 1926 she was elected an honorary Fellow of the Hall. After her retirement she lived with her sister, formerly Mistress of Girton, first in London and then in Kent.

Miss Jex-Blake and her sisters had received an excellent education in the home under her father's care and was a good linguist, a highly accomplished musician and was widely read in the literature of several countries. She had travelled widely, particularly in France, Spain and Italy. She was in all her ways a lady of the old-fashioned kind, self-disciplined and imposing a high standard of conduct on herself and others. Though somewhat shy and reserved, she was most generous to those in need or trouble, and many members of the Hall owed much to her carefully concealed assistance. A graduate studentship at Lady Margaret Hall bearing her name has been formed from capital provided by her.

We regret to announce the following deaths:

Lieut.-General Sir William Furse, K.C.B., K.C.M.G., director of the Imperial Institute, London, during 1926–34, on May 31, aged eighty-eight.

Sir Thomas Hunter, K.B.E., emeritus principal of Victoria University College, Wellington, and vice-chancellor during 1929–47 of the University of New Zealand, aged seventy-six.

M. Camille Raveau, editing secretary of the *Comptes rendus* of the Paris Academy of Sciences during 1904–46 and known also for his work in the field of thermodynamics, on April 15, aged eighty-six.

NEWS and VIEWS

Applied Mathematics at Swansea: Prof. J. G. Oldroyd

Dr. J. G. Oldroyd has been appointed to the recently created chair in applied mathematics in the University College of Swansea. This post is within the Department of Mathematics, under the direction of Prof. R. Wilson, and the holder of the new chair will be responsible for teaching and research in applied mathematics in the College and will have his own staff for the purpose. Dr. Oldroyd has had a distinguished academic career. He was educated at the Bradford Grammar School and was a scholar of Trinity College, Cambridge. He was a Wrangler in 1941 and was awarded a distinction in Part III of the Mathematical Tripos in 1942; during this period he obtained the Rouse Ball, Mathison and Mayhew Prizes. In 1942 he entered the Projectile Development Establishment at Boncath, Cardiganshire, and remained there until 1945, when he joined the laboratory for fundamental research of Messrs. Courtaulds, Ltd., as a mathematical physicist. At their request he spent a year in research studies at Trinity College, Cambridge, and while still with Messrs. Courtaulds was elected to a research fellowship of Trinity College for the period 1947–51. He is honorary treasurer of the British Society of Rheology and of the Second International Congress on Rheology. He is also a member of the weapons research panel of the Ministry of Supply. His numerous publications relate to the theory of viscous flow, plastic flow and finite elastic deformation, especially in materials which have both viscous and elastic properties combined. His experience in these fields may be of help to the local industries at Swansea, which include the refining and circulation of oil products and the working of molten steel. Dr. Oldroyd's work will be of great interest to the Physical Science Departments and, in particular, to the Departments of Engineering and Metallurgy in the College.

New Nature Reserves in Britain

Following its declaration last summer as a national Nature reserve of 100 acres forming part of a small chalk coomb on the southern edge of the South Downs, some four miles north-west of Chichester, the Nature Conservancy has now added a further 100 acres to its Kingley Vale Nature Reserve, which nearly completes the acquisition of the natural yew woods, some of the trees of which are very old. About 76 acres, known as Mincing Wood and Crawford's Rough, of the extensive woodlands near Blean, Kent, have also been acquired by the Conservancy, and are being declared a national Nature reserve. The woods include sessile oak with hazel and hornbeam coppice, chestnut and birch, and contain a variety of unusual plants. The importance and value of the reserve are greatly increased by the presence of a species of butterfly, the heath fritillary, which occurs here and practically nowhere else in Britain, though its food plant (a semi-parasitic species) is well distributed elsewhere. Monk's Wood, about 375 acres of woodland, some five miles north-east of Huntingdon, has also been acquired and declared a Nature reserve. The area is the last of the few remaining examples of the ancient ash – oak woodland of the heavy Huntingdonshire clays, and is a classic locality for the characteristic fauna of such woodland, containing rare plants as well as rare insects. Although the wood was largely cut down during the First World War, natural regeneration has allowed the persistence of the most characteristic species. A further 84 acres, known as Barrow Wood, and part of the wood known as Hibbet's Wood, have been added to the 155 acres declared as the Ham Street Woods Reserve, Kent, in May 1952. This type of woodland—standards with coppice—is declining in this neighbourhood, and the Wild Life Conservation Special Committee recommended that samples of this type of woodland with its characteristic flora should be maintained to preserve the rich insect fauna, including species that seem to be disappearing or to have disappeared from other similar woods.

American Aid for Industrial and Technological Research in Britain

Arrangements for the expenditure of counterpart funds, amounting to nine million dollars, derived from the United States Economic Aid under

Section 9 (c) of the Mutual Security Act of 1952, are detailed in a Command Paper (Cmd. 8776; United States No. 1 (1953), dated February 25, 1953. London: H.M.S.O.; 6d.). The programme is based on the conclusion that there is need for wider knowledge throughout British industry of the best and most modern techniques and practices. It provides for the employment of technical advisers on reorganization and production techniques, who might be members of the staff of research or business organizations if they specialized in the problems of particular industries, or might work under contract for, say, the British Productivity Council or the Department of Scientific and Industrial Research, if they specialized in techniques applicable to the whole of industry. Expenditure for this purpose during two to three years is estimated at £457,000. A further sum, estimated at one million pounds during two or three years, is set aside for the expansion of research into factors affecting the efficiency of the national economy, including, for example, medical work on the design of machine controls and industrial fatigue problems; research into the sociology and social psychology of the relations between employer, management and employed; economic descriptive, statistical and theoretical work on the structure of industry; and the structure and practice of trade associations and trade unions. Such a programme would be carried out largely under contract by such bodies as the universities, economic or sociological institutes, the British Institute of Management and other professional and learned bodies. Further proposals include the promotion of studies in technological subjects at universities and technical colleges; the training of staff for courses for supervisors; and the provision of scholarships, including scholarships for trade unionists, in management subjects, part of which proposal might be a contribution by endowment to the building up, recently announced by the Government, of an institution of university rank devoted predominantly to the teaching and practice of technology. Expenditure of £178,000 on publicity for the programme is also proposed, and a revolving fund of £1 million for short-term loans to industry for equipment and reorganization and, for special purposes, to agriculture. The President of the Board of Trade will be generally responsible for co-ordinating the programme and for general policy.

British Journal of Animal Behaviour

The study of animal behaviour, or comparative ethology, is attracting an impressive number of young students and probably stands in much the same position to-day as did genetics in the early days of this century and endocrinology in the decade following the First World War. The recent launching of a new quarterly, *The British Journal of Animal Behaviour* (1, No. 1; January 1953; obtainable from Baillière, Tindall and Cox, Ltd., 7–8 Henrietta Street, London, W.C.2), is therefore both timely and justified. The new *Journal* is the official organ of the Association (formerly Institute) for the Study of Animal Behaviour which was founded in 1936 and which, almost from the time of its inception, offered research grants for the study of ethology and published a small *Bulletin* which, issued at irregular intervals, has contained many admirable papers. The new quarterly replaces the *Bulletin* and will henceforward publish an increased number of contributions dealing with the physiology and psychology of behaviour of wild and domestic animals. The *Journal* is edited by Prof. A. N. Worden and Dr. B. A. Cross, assisted by a remarkably strong editorial board. It is pleasant to see on this the names of Julian Huxley and James Fisher, who, with F. B. Kirkman, were largely responsible for the formation of the Association. The first issue contains seven papers, five of which deal with the behaviour of vertebrates. There is a stimulating discussion on the term 'mimesis' by R. A. Hinde and E. A. Armstrong, and an editorial by Dr. W. H. Thorpe. It has to be admitted that this initial number is a little patchy in quality. One paper, largely composed of material taken from books and other papers, would have been better left out in favour of more original work. Further, there occur an unusual number of conspicuous misprints. These, however, are minor matters and need not be repeated in future volumes. One can predict with confidence that the new publication will quickly find its way into scientific libraries all over the world.

Aluminium Laboratories, Ltd.

An increase in the research facilities of the aluminium industry is marked by the completion of the first stage of the extensions to the Banbury premises of Aluminium Laboratories, Ltd. The company, which is the research and engineering organization of the Aluminium, Ltd., Group, already has laboratories at Kingston and Arvida in Canada and a design office at Geneva, in addition to the Banbury laboratories which are adjacent to the plant of the associated company, Northern Aluminium Co., Ltd. The full scheme, to be complet d by mid-1954, will increase the floor area threefold, and the present extensions have more than doubled the available accommodation by the addition of a large laboratory wing to the existing buildings and the erection of a new experimental block. This expansion of research facilities runs parallel with the Aluminium, Ltd., Group's development of productive capacity as typified by the Northern Aluminium Company's continuous strip mill at Rogerstone and by the expansion programme of the Aluminium Company of Canada, Ltd., at Kitimat, British Columbia. The new buildings were designed by Sir Percy Thomas and Son, and incorporate a number of novel features, including a central hollow wall running the whole length of the laboratory block, providing a vertical and uninterrupted duct on two floors in which all services are carried. Space heating is by aluminium panel ceilings with incorporated flush lighting and acoustical correction. Much use has been made of aluminium for windows, pitched roof trusses and coverings, partition framing, rainwater fittings, etc.

Lundy Field Society

The sixth annual report of the Lundy Field Society is a record of continued progress, notably in ornithology. Of the 129 species of birds recorded in 1952, four were observed at Lundy for the first time. Among the rarer visitors were the little crake, the red-rumped swallow, the American robin, White's thrush and the red-headed bunting. During the year a study of ectoparasites on birds was begun and this work is being extended; the ectoparasites included *Ornithomyia fringillina*, which was found on the chiff-chaff and so adds another host to the already long list of hosts of the British species of *Ornithomyia*. Botanical investigations were designed to emphasize differences in the plant populations on the east and west coasts of Lundy and, from this

preliminary work, two lines of research were undertaken to investigate the differences in the bracken (*Pteridium*) population on the two sides of the island and the plants associated with the thrift (*Armeria*) in the gullies of the west coast.

Royal Commission for the Exhibition of 1851 : Awards for 1953

THE Royal Commission for the Exhibition of 1851 has awarded senior studentships for 1953 (value £600 a year for two years) to the following for research as indicated : Miss M. P. V. Boarland (Bristol), organic chemistry at the Federal Technical College, Zurich ; P. W. Higgs (London), theoretical physics at King's College, London ; Dr. M. G. K. Menon (Bombay and Bristol), experimental physics at the University of Bristol ; and J. C. Ritchie (Aberdeen), botany at the University of Manitoba and the Botanical Gardens, Montreal. The Commission has also awarded the following overseas scholarships for 1953 (value £450–500 a year for two years) : Canada : R. G. Ackman (Dalhousie), organic chemistry at the Imperial College of Science and Technology, London ; G. M. Graham (Dalhousie), physics at the University of Cambridge ; and Miss M. M. Moodie (British Columbia), radiochemistry at the University of Cambridge. Australia : N. W. Tanner (Melbourne), physics at the University of Cambridge ; and J. S. Turner (Sydney), physics at the Imperial College of Science and Technology, London. New Zealand : R. Hodges (New Zealand), organic chemistry at the University of Manchester. Republic of Ireland : Miss K. M. W. Gallagher (National University of Ireland), organic chemistry at the University of Bristol. Republic of India : S. Varadarajan (Delhi), organic chemistry at the University of Cambridge. Pakistan : F. H. Chowdhury (Dacca), chemistry at the University of Manchester.

Leverhulme Research Awards for 1953

THE following have been awarded Leverhulme research fellowships, tenable for periods up to two years, for research as indicated : Dr. (Miss) D. Atkins (research worker), comparative studies of ciliary feeding mechanisms of Brachiopods and their allies ; and Dr. E. R. Leach (reader in anthropology, University of London), study of traditional village organization among the Sinhalese of the Dry Zone of Ceylon. Leverhulme research grants have been awarded as follows : Dr. D. R. Arthur (lecturer in zoology, King's College, London), functional morphology of the genera *Ixodes* and *Dermacentor* in relation to their ecology ; J. Bor (senior lecturer in physics, West Ham College of Technology), determination of the optical constants of metals and alloys ; E. J. H. Corner (lecturer in botany, University of Cambridge), revision of the genus *Ficus* for the Flora Malesiana Foundation ; W. F. Grimes (director, London Museum), petrology of implements of the Neolithic and Bronze Ages in Great Britain ; Dr. G. Heslop-Harrison (lecturer in agricultural zoology, University of Durham), evolution and speciation of the Psyllidæ of Spain and Portugal ; Dr. R. J. W. McLaughlin (demonstrator, University of Cambridge), differential thermal analysis of clay materials ; D. P. MacPherson (community centre warden, Lanarkshire), Gaelic folklore from Vatersay and Isle of Barra sources ; Dr. T. B. Reynoldson (senior lecturer in zoology, University College, Bangor), the taxonomy and ecology of pond and lake planarians ; and Dr. A. J. Ward (lecturer in mathematics, University of Cambridge), general topology.

National Research Council of Canada : Scholarships and Fellowships in Science and Engineering

THE National Research Council of Canada has granted 226 scholarships in science and engineering for 1953–54, totalling 224,000 dollars in value. These scholarships include 61 bursaries of 600 dollars each, 113 studentships worth 900 dollars, and 13 fellowships worth 1,200 dollars, nearly all of which are to be held in Canada. Special scholarships awarded for study outside Canada include seventeen awards of 1,500 dollars each, and seven awards worth 1,200 dollars each. These special scholarships are to be held in the following universities : eight at London, four at Cambridge, three at Oxford, two each at Birmingham and North Carolina, and one each at the Massachusetts Institute of Technology, and the universities of Chicago, Delaware, Pennsylvania and Wisconsin. One additional special scholarship worth 1,200 dollars has been awarded for study in Canada, at the University of Western Ontario. Fourteen overseas post-doctorate fellowships, each worth 2,500 dollars, have been granted for work at the following universities : three each at Oxford, Cambridge and London, and one each at the National Institute for Medical Research, and the universities of Birmingham, Leyden, Louvain and Uppsala.

Royal Meteorological Society : Officers for 1953–54

THE officers and council for 1953–54 of the Royal Meteorological Society are as follows : *President*, Prof. O. G. Sutton ; *Vice-Presidents*, Prof. P. R. Crowe, Sir Charles Normand, Mr. C. D. Ovey and Prof. P. A. Sheppard ; *Vice-President for Canada*, Mr. F. W. Benum ; *Vice-President for Scotland*, Dr. A. E. M. Geddes ; *Treasurer*, Dr. J. S. Farquharson ; *Secretaries*, Dr. H. L. Penman, Dr. G. D. Robinson (*Librarian*), Mr. R. G. Veryard and Dr. T. W. Wormell (*Editor*) ; *Council*, Mr. G. A. Bull, Mr. H. Charnock, Instr. Cdr. C. R. Darlington, Mrs. A. C. Douglas, Dr. A. G. Forsdyke, Dr. R. Frith, Dr. G. L. Hogben, Mr. R. E. Lacy, Mr. F. H. Ludlam, Mr. N. Pye and Dr. R. S. Scorer.

Sir Henry Wellcome Centenary Exhibition

To mark the centenary of the birth of Sir Henry Wellcome on August 21, 1853, a commemorative exhibition will be opened at the Wellcome Foundation, Ltd., on Wednesday, July 8, by Mr. Winthrop W. Aldrich, American Ambassador in London. This exhibition, which has been arranged and designed by the Wellcome Historical Medical Museum, will cover the whole period of Sir Henry's long life (1853–1936). The exhibits will range from interesting relics of his early days in the United States to sections on some of the world-famous research institutes which he established after he settled in Great Britain : the Wellcome Physiological Research Laboratories, Wellcome Chemical Research Laboratories, Wellcome Research Institution, Wellcome Museum of Medical Science, and Wellcome Historical Medical Museum and Library. It also deals with Wellcome's archæological expeditions to the Sudan and Palestine.

Symposium on Plasticity

A SYMPOSIUM on plasticity, the fourth of its kind, will be held at Brown University, Providence, R.I., during September 1–3, under the auspices of the University, the Engineering Mechanics Division of

the American Society of Civil Engineers and the Office of Naval Research. The three principal topics to be discussed will be stress-strain relations (perfectly plastic, work-hardening, visco-elastic and visco-plastic materials); distribution of stress and strain in bodies exhibiting inelastic properties (static and dynamic problems, infinitesimal and finite deformations); and structural analysis and design in the inelastic range (limit analysis, static and dynamic loading, shakedown and inelastic buckling). The symposium is open to all. Further information can be obtained from Prof. H. J. Weiss, Graduate Division of Applied Mathematics, Brown University, Providence 12, R.I.

Announcements

It is announced from the University of London that Sir Roderic Hill, rector of the Imperial College of Science and Technology, has been elected vice-chancellor from September 1 for the university year 1953–54. Sir Alexander Carr-Saunders, director of the London School of Economics and Political Science, has been re-appointed deputy vice-chancellor for the university year 1953–54.

The following appointments have been made in the University of Sheffield: Dr. R. G. Wilkins, lecturer in chemistry; and Dr. N. M. Green, lecturer in biochemistry.

The Institute of Economic Engineering was founded in 1941, and is concerned with such topics as cost control, production planning and control, factory layout, methods engineering and work study, and incentives. These techniques are now becoming more widely known as industrial engineering, and the title of the Institute has accordingly been changed to the Society of Industrial Engineers. The offices of the Society are at 28 Victoria Street, London, S.W.1.

A residential conference on information service is being arranged by Aslib and will be held in the University of Nottingham during September 11–14. Communication problems, training for personnel in the field from different national aspects, methods of document copying, and administrative problems are among the topics to be discussed. Particulars can be obtained from the Director, Aslib, 4 Palace Gate, London, W.8.

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory, Cambridge, during September 22–October 2. The course, which will be along the same lines as those held previously, will give a basic training in the mathematical use of machines in general, dealing with the processes employed and their embodiment in programmes which specify the operation in detail, and lectures and practical classes will be held in the design of programmes for the Cambridge machine known as Edsac. Application forms (to be returned by July 18) and further information can be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

A joint meeting of the First and Second Commission of the Institut International du Froid will be held at the Federal Technical College, Zurich, during September 10–12. It will be under the auspices of the Institut für Kalorische Apparate und Kältetechnik der E.T.H. and the Physikalisch-Chemisches Institut of the University of Zurich, and will deal with the practical applications of very low temperatures: (1) gas separation by liquefaction, distillation, rectification and adsorption; (2) properties of materials used at low temperatures. Further information may be obtained from the Sekretariat, Institut für Kalorische Apparate und Kältetechnik, Eidg. Techn. Hochschule, Sonneggstrasse 3, Zurich.

The governing body of King's College, Cambridge, proposes shortly to award a fellowship intended to enable a man of proved distinction to undertake or complete a particular piece of work. While holding the fellowship, he would receive emoluments commensurate with his age and standing without the necessity of performing other specified duties. Further details can be obtained from the Provost of the College, to whom applications must be returned by October 1, 1953.

The trustees of the Plastics Industry Education Fund have recently provided a sum of £2,000 for the provision of scholarships, worth £125 a year for two years, and tenable at the Plastics Technology Department of the Borough Polytechnic, London, S.E.1, which will be open to young men already employed in the industry, or for boys leaving grammar and technical secondary schools. These scholarships, of which eight will be offered this year, will enable the holder to study for the diploma of the Plastics Institute, which is the preliminary step to the associateship of the Plastics Institute. They are only open to boys living in the United Kingdom who have reached the standard of the General Certificate of Education (ordinary level) in chemistry, physics and mathematics. Application should be made in the first instance to the Head of the Chemistry Department, Borough Polytechnic, Borough Road, London, S.E.1.

Because of the large increase in the number of papers received for publication in the *Australian Journal of Scientific Research*, Series A (Physical Sciences), the journal has been divided into the *Australian Journal of Chemistry* and the *Australian Journal of Physics*, each issued quarterly. The volume numbers continue from the earlier publication. The *Australian Journal of Biological Sciences* is the new title of the former *Australian Journal of Scientific Research*, Series B (Biological Sciences), and the publication of two new journals, the *Australian Journal of Botany* and the *Australian Journal of Zoology*, issued as material becomes available, is announced. All the journals are published by the Commonwealth Scientific and Industrial Research Organization, in collaboration with the Australian National Research Council.

The International Wool Secretariat has recently published a "World Wool Map", produced as a teaching aid by the Department of Education of the Secretariat. The map shows the wool-producing areas of the world with the numbers of sheep for 1950 and also the spinning areas and total production. A separate and more detailed map for the United Kingdom and Eire on the same sheet indicates also the characteristic breeds for the different districts and, besides the raw wool production, the total consumption of scoured wool in 1950 and the location of areas of consumption as woollen and worsteds, hosiery, carpets and felts. The sheet is obtainable from the Secretariat, Dorland House, 16–20 Regent Street, London, S.W.1, price 5*s*. per copy.

Erratum. In the article on "Synoptic Rocket Observations of the Upper Atmosphere" published in the issue of June 20, for "Prof. L. F. Bates" read "Prof. D. R. Bates" (p. 1109, col. 1, line 4).

COLLOID SCIENCE AND SOME OF ITS INDUSTRIAL APPLICATIONS*

By Dr. R. MATALON

Department of Physical Chemistry, King's College, London

It is undoubtedly true that fundamental research carried out in surface chemistry for more than forty years has now enabled technicians and engineers to find new and simpler methods for solving industrial problems as well as improving current processes in practically all fields: for example, textiles, metallurgy, cosmetics, drugs, paints and lubricants. In view of the importance of this growing field of science, some of the latest theoretical developments will be discussed with the object of encouraging applied research, using as a basis the fundamental approach that is now the subject of inquiry in the universities, and which, it may be hoped, will be taken up by other institutions conducting research in pure and applied science.

Considering first in its broadest sense orientated adsorption and its importance in determining colloidal behaviour, in which the pioneering work was done by Sir William Hardy, Lord Rayleigh and Devaux, the main factors are gaseous, liquid expanded, liquid condensed, viscous elastic and solid surface-films in relation to the molecular structure of the spread compound, to molecular packing, and to the cohesive forces such as are brought about by van der Waals forces, polar forces, hydrogen bonding and the like; the main observations on surface-films have been made with the Langmuir balance. The more recent approach is that of the school of Sir Eric Rideal on the study of reactions in surface-films: the extent to which the rate of reactions is affected by orientation and packing has been demonstrated by A. Hughes and Rideal for the oxidation of fatty acids, by A. E. Alexander for the hydrolysis of esters, and by J. H. Schulman and Hughes for the lypolysis by enzymes. In addition, molecular interaction in monolayers has been studied extensively by Rideal, Schulman, E. Stenhagen, E. G. Cockbain and R. Matalon.

The surface-film technique has indeed enabled the study of the reaction of tanning of proteins using tannic acid and phenols as well as polyvalent metallic ions such as ferric chloride. On the other hand, when the molecular interaction results in the 'penetration' of the solute molecules into the surface-film, a mixed structure of both components is observed. This type of interaction produces a solution complex or a stoichiometric association depending on the relative affinity of the interacting molecules. Penetration is observed at both the air/water and the oil/water interfaces. In the latter case, the relation between the surface pressures of the mixed film π_m and that of the single components π_1 and π_2, present alone at the same interface, may be exemplified for the system cholesterol – laurylsulphate. Whereas, as a general rule, the more surface-active component displaces from the surface the less active one, when penetration occurs the final surface pressure of the system exceeds that of any one of the single components π_1 and π_2, and in dilute systems $\pi_m = \pi_1 + \pi_2$. When the interacted mixed film is liquid, molecular interaction in bulk solution, as shown by Dervichian, results in the appearance of myelinic figures and tactoids.

There are a number of examples of the role of penetrated films in spontaneous emulsification. Thus the presence of a trace of a penetrating substance such as *iso*-octylalcohol in an alkylsulphonate greatly enhances the wetting of fibres and paper. The effect of adsorption on solids is illustrated by a simple experiment: copper chromate precipitated by the reaction of copper sulphate and potassium chromate is produced in the flocculated state when a trace of sodium oleate is added to the chromate. Finally, the periodicity observed in the Liesegang phenomenon is exemplified in the case of silver chromate, in which the adsorption complex gelatin – silver chromate is responsible for the periodicity observed.

Turning now to foams and the fundamental properties connected with foaming, the first requirement is that the molecules must rapidly diffuse from the bulk to the surface, the second that the adsorbed molecules must lead to a surface layer which is either condensed viscous or elastic, and the third that the surface layer must be somehow insolubilized—that is, showing a slow rate of desorption.

The traction apparatus developed by me shows the behaviour of surfaces on traction and retraction with saponins, proteins, beer and the synthetic surface-active agents. Saponins and proteins lead to an irreversible pattern on traction and retraction, whereas the alkylsulphate shows a reversible behaviour. Foaming may be done with anionic and cationic derivatives and also with non-ionics, as exemplified by the good foaming obtained with a condensate of heptylalcohol and six molecules of ethylene oxide. The part played by additives such as methylcellulose, alginic acid and polyvinyl alcohol in stabilizing the foam can be attributed to the more coherent structure obtained as a result of interaction with the foaming agent. There is a grave lack of quantitative work on the equally important field of defoaming. One of the important factors in defoaming is the displacement of a coherent surface layer by a compound, leading to a higher surface pressure and to a gaseous type of film. Defoaming of fermentation baths by the addition of alkylbenzenesulphonate is a direct example of this.

The useful applications of foaming in industry are manifold, as is indicated by the following selection: in fire-fighting; in food, such as in the manufacture of aerated chocolates, creams and meringues; in cosmetics, shampoos and washing powders; in building materials, such as porous concrete and light aggregates; and in the rubber industry, where porous rubber of both types may be obtained, those with isolated cells and with intercommunicating cells. On the other hand, the various instances where foaming is undesirable and combated are in the manufacture of photographic paper; in the course of distillation; in the working of lubricating oils; during fermentation; and in drilling muds.

* Substance of five lectures delivered at King's College, London, on January 13 and 27, February 10 and 24, and March 10.

Another aspect of colloids is that of emulsions, and the factors of importance in this colloidal state are: the emulsifier and its orientation at the interface; the mechanical properties of the interfacial film; its electrical properties; the relative density of the phases in contact; and the volume phase ratio. The role of the hydrophobic–hydrophilic balance of the emulsifier in determining the type of emulsion obtained is shown in the case of the ethylene oxide condensate with long-chain polar compounds. The nature of the oil must also be considered in relation to the emulsifier, and it can be shown that oleyl alcohol condensed with three ethylene oxide molecules leads to very good oil-in-water emulsions of spindle oil. For triolein, optimum emulsification is obtained with eight to ten molecules of ethylene oxide condensed on the oleyl alcohol. For oleic acid the emulsification is satisfactory with a condensate of fifteen molecules of ethylene oxide on the oleyl alcohol.

In considering the stability of the emulsion in relation to creaming and coalescence, the role of thickeners such as gums, clays, polyvinylalcohols in stabilizing emulsions is attributed to the effect of these materials in slowing down the creaming. Coalescence can now be studied directly by the traction curve of laminæ and by the life-time of droplets at the oil–water interface; the latter method has recently been developed by Cockbain and Roberts. In general, need for further study of emulsions lies in the importance of their role in industry, as, for example, in food for the manufacture of margarine, ice cream, mayonnaise, etc.; in textiles for the lubrication of yarn, the fulling of wool, sizing, mothproofing, etc.; the printing of cotton; the processing of leather; paints and distempers; polishes; insecticidal and fungicidal preparations; cutting-oils to aid the machining of metal, leading to higher cutting speeds and better finish of the surface; and the water–oil emulsions used for drilling muds.

Turning next to the phenomenon of wetting in colloids, the principles of wetting solids, the methods used for describing and studying this interesting property and finally the various applications of wettability in industrial practice must be considered. The measurement of the contact angle θ at the solid/liquid/air interface may be made by various techniques such as the capillary rise, the tilting plate and by direct observation using a microscope or any other magnifying equipment. The recent approach of J. Guastalla and his co-workers on the measurement of the adhesion tension is simple and entirely satisfactory for the study of wetting. The traction and retraction curve obtained with a solid plate makes it possible to determine the advancing and receding contact angle by direct applications of the formula $F = \gamma \cos \theta$ on a liquid surface of tension γ.

In the problem of dispersing and suspending solids, the important factors are particle size and adsorption at the interface of the added wetting agents and builders. Wetting agents find numerous and important applications in industry. Thus, in the pickling of metals, where the introduction of a wetting agent reduces the consumption of acid, loss of metal and processing time, a brighter surface is obtained. In electroplating, wetting agents prevent the adhesion of hydrogen bubbles, as well as control the structure of the deposit (for example, in bright nickel plating), and in the cleaning of metal they remove grease and dirt from surfaces. In soldering, a suitable wetting agent will enable spreading of the zinc chloride – ammonium chloride fluxes, and in the phosphating of steel 0·02 per cent dodecylbenzene sulphonate produces a uniformly treated layer. Phenolic bodies and short-chain alkylsulphonates ensure rapid mercerization of cotton, and wetting agents are good levelling agents in the dyeing of textiles; non-crystalline wetting agents, liquids or pastes, effect quick re-wetting of the textiles after drying. Other uses of wetting agents are in the extinguishing of fires, in accelerating reactions, such as the development of photographic films, and in the ethylation of cellulose, etc. Wetting and dispersion of solids play an important part in the manufacture of paints and varnishes, metallic soaps being here used for promoting wetting and quick dispersion of the pigments in the vehicle. Alkylbenzene and alkylnaphthalene are added in lubricating oils for the dispersion of carbon black. Finally, wetting agents play an important part in the processing of wettable powders used in medicine, in insecticides and in fungicides.

Dealing now with precipitation and growth regulation in supersaturated solutions and in precipitation reactions, a factor of importance is the metastability of the supersaturated system, which may be considered in parallel with the effect of mechanical shock, dust impurities or nuclei. The effect of interfacial forces in determining crystallization is exemplified in the overgrowth phenomenon, and excellent photographs obtained by Dr. M. Blackman and Mr. N. D. Liesegarten (Imperial College of Science and Technology, London) demonstrate the results obtained with potassium chloride, ammonium iodide, rubidium iodide and potassium bromide on mica.

Apart from the effect of the solvent in determining crystal habit, various additives, anionic or cationic, also play a part, as may be demonstrated by the effect of these surface-active agents on the crystal habit of succinic acid. Inhibitors of crystallization have been studied in the case of copper sulphate by A. Packter and myself, and our observations show that as a result of adsorption the time necessary for the appearance of the first visible crystals is increased, and that with increasing addition of inhibitor the crystal size first increases and then decreases again. The effect of sodium laurylsulphate in stratifying copper sulphate crystals is attributed to the adsorption on the copper ion of the long hydrocarbon chain, and the stratification of lead nitrate by agar is paralleled with the rhythmicity of the lead salts in agar.

The conditions affecting precipitation reactions are the primary factors of molecular ratio, concentration and temperature, and secondary factors of *p*H and other added reagents. The high degree of supersaturation observed in precipitation reactions is ascribed to precipitation complexes, such as $AgCl\,Ag^+$, $Ag_2CrO_4\,Ag^+$, etc. Precipitation inhibitors act by adsorption on to the precipitated sol and thus prevent crystal growth. Finally, the Liesegang phenomenon is a special case of precipitation reaction where adsorption on the precipitate is very pronounced. In general, the importance of controlling precipitation and growth of crystals is very great in the various applications of colloids, such as the preparation of stable sols in medicine, in the photographic industry, in electroplating, etc., and in the production of large crystals.

PHYSICAL SOCIETY

REPORT FOR 1952

AT the annual general meeting of the Physical Society, held at the Imperial College of Science and Technology, London, on May 15, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1952 were presented and adopted, and the officers and council for 1953–54 were elected (see *Nature*, May 30, p. 958). At the extraordinary general meeting held immediately after the annual general meeting, new articles of association and new rules of the Society, as approved by the Board of Trade, were finally approved and adopted. During 1952 the membership of the Society rose to 2,101—a net increase of seventy-six. The total income from subscriptions was £5,231; but this was less than the cost, £5,799, of providing the membership with the normal amenities and privileges. The new scheme of subscriptions, approved in principle in 1951, was adopted at an extraordinary general meeting held on October 3, 1952, and came into operation on January 1 this year. Under this scheme subscriptions for publications are separated from the subscriptions for membership, and thus the cost, £2,569, of providing members with *Physics Abstracts* during 1952 appears as an expense for the last time. In future the Society should be able to extend the amenities given to its Fellows. The thirty-sixth annual exhibition of scientific instruments and apparatus, held during April 3–8, 1952, was a great success with an attendance of thirteen thousand and resulted in a benefit to the Society of £4,000. This enabled the Society to finish the year with a balance of income over expenditure of approximately £2,500.

Eight science meetings were held in London during the year and two-day meetings at, respectively, the H. H. Wills Physical Laboratories, University of Bristol, at the University of Glasgow and at the Physical Laboratories, University of Manchester. The thirty-sixth Guthrie Lecture[1] was delivered by Sir Lawrence Bragg, who spoke on the X-ray analysis of proteins, and the sixth Rutherford Lecture[2] by Prof. R. E. Peierls, on the atomic nucleus and its constituents. Prof. L. Néel was the recipient of the seventh Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place at the Royal Institution on May 27, when Prof. Néel delivered the Holweck Discourse[3] on the subject of antiferromagnetism and ferrimagnetism. The twenty-ninth Duddell Medal was presented to Mr. C. Waller, who gave a talk on some topics concerning the production and application of nuclear emulsions, and the eighth Charles Vernon Boys Prize to Dr. B. Bleaney, who spoke on paramagnetic resonance at low temperatures.

The Society continues to be represented on various joint committees and bodies, details of which are listed in the annual report, together with accounts of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustic Groups. In addition to science meetings, the Colour Group paid a summer visit to Cambridge, and the Low Temperature Group held its second overseas meeting early in November, when a party of twenty-four members visited laboratories and industrial plants in Holland.

The Society's Library has in the past been the joint responsibility of the Society and of the Institute of Physics, but the Board of the Institute has recently suggested that the Library would be better administered by the Society alone. It has presented to the Society all books and journals of the Institute at present in the Library and is continuing to pass on to the Library periodicals received in exchange for the Institute journals. The grant received during the year from the Royal Society for the development of the Library has been used mainly for cataloguing and for increasing the shelf space. This has been largely facilitated by the acquisition of a large council chamber at the Society's headquarters. A complete card-index to both text-books and periodicals is now available.

The average time of publication of papers in the Society's *Proceedings* has improved, so the report states, from five and a half months in 1951 to slightly less than five months in 1952, with the hope of still greater improvement in the near future. Both Sections *A* and *B* of the *Proceedings* contained about 115 papers each, but there were about twice as many "Letters to the Editor" in Section *A* as in *B*. The referees are again praised for their valuable services in keeping a careful check on the papers submitted for publication and for maintaining a high standard in content, style and composition. Of 295 papers and 141 letters submitted, approximately seventy were rejected as unsuitable for publication. Vol. 15 of "Reports on Progress in Physics", containing nine reports and a cumulative index of authors and contents of Vols. 1–15, was published during 1952, and Vol. 16 and a comprehensive cumulative subject index to Vols. 1–10 are in active preparation for publication this year.

[1] *Proc. Phys. Soc.*, B, **65**, 833 (1952).
[2] *Proc. Phys. Soc.*, A, **66**, 313 (1953).
[3] *Proc. Phys. Soc.*, A, **65**, 869 (1952).

INTERNATIONAL CO-OPERATION IN SCIENCE

THE report of a symposium on development of international co-operation in science held at Washington on October 18, 1951, in conjunction with the third annual meeting of the Executive Board of the International Council of Scientific Unions, has been issued by the National Academy of Sciences and the National Research Council (Development of International Cooperation in Science: a Symposium held in conjunction with the Third Annual Meeting of the Executive Board, International Council of Scientific Unions, October 18, 1951, Washington, D.C. Pp. 28. (Washington, D.C.: National Academy of Sciences/National Research Council, 1952)). It includes Prof. F. J. M. Stratton's brief review of the development of international co-operation in science during the past century down to the formation of the United Nations Educational, Scientific and Cultural Organization, and comments on the necessity which now confronts the Council and the Unions of either curtailing their activities or increasing their incomes; and the review of some international scientific joint ventures, for example, in publications, international surveys and laboratories, exchanges of scientists and the co-operative use of natural resources, made by Dr. W. A. Noyes, jun., in which he indicated some of the difficulties and the necessity of an open-minded approach to the problems, is also published.

Dr. J. N. Mukherjee described the attitude of Asia and the Far East, and Dr. C. J. Mackenzie, in putting

the Canadian point of view, referred to the importance of ensuring that representatives on the various bodies are chosen by scientists who are competent and knowledgeable about the work being done in all parts of the world. He believes that the existing organization is as good as any likely to be devised, provided the support of really first-class men is obtained and any moribund or inefficient parts that might develop in the organization are discarded. Dr. J. B. Koepfli's address, "Science and Foreign Relations", described the events leading to the creation in February 1951 of the Office of Science Adviser to the United States Department of State, and the way in which the activities of the Office are assisting international co-operation in science and encouraging international scientific organizations. The two main difficulties in its work, he thinks, are the administrative delays in the admission of foreign scientists into the United States and the legislative ceiling to the United States support of the International Council and the Scientific Unions. Scientists, he suggested, can help to overcome both these obstacles by fostering among themselves a fuller understanding of the United States' objectives and immigration laws, and by making the plans and work of the Council and its Unions more widely and fully known.

The address by Prof. A. von Muralt on international and national aspects of science directed attention to the importance of finding new ways of maintaining the atmosphere in which scientific development is best fostered, including new ways for arranging scientific congresses in view of the numbers attending, and new techniques for handling the dissemination and co-ordination of knowledge. While not over-rating the influence of scientific men, he believes that their efforts at international co-operation in science can contribute notably towards a wider understanding between all countries.

PHYSICAL APPLICATIONS OF HIGH-SPEED ROTATION

THE substance of a lecture entitled "Some Scientific Applications of High-Speed Rotation", delivered by Prof. P. B. Moon on April 27, 1951, to the South Wales Branch of the Institute of Physics, is printed as a special article in the *British Journal of Applied Physics* (**4**, 97; April 1953). First, brief reference is made to the familiar classical examples such as those to be found in the measurement of the velocity of light, the molecular pump and the centrifuge, and to the fundamental researches of Oliver Lodge (1897), where an attempt was made to 'drag' the ether by rotating disks, and of Blackett (1952), where the test was made, though unsuccessfully, to detect the magnetic field produced by a massive body rotating with the earth. The principles of rotor design are then discussed, and the best shape of rotor for attaining the highest practicable linear velocity at the periphery is considered. It is pointed out that, while the ideal shape is independent of the material and of the size, it is governed by the criterion of equal stress at all parts of the rotor. For a thin rod spinning about an axis perpendicular to its length, the ideal shape is that of a Gauss error-curve, and for a disk-like rotor the disk should be thin at the edge and the profile that of the Gauss error-function.

The various methods that have been used for driving rotors and their particular advantages and applications are next discussed. A detailed description is given of the particular method[1] introduced recently at the University of Birmingham, which Prof. Moon claims is nearly as simple as that of Colwell and Hall and nearly as effective as that of Beams. The rotor used consists of a doubly tapered steel rod with a small ball of hardened steel at its base. The ball runs on a glass plate, and an electromagnet suspended by a short thread to act as a conical pendulum supports and takes up about 90 per cent of the weight of the rotor. Peripheral speeds of up to 10^5 cm./sec. have been attained with a six-inch rotor. Various examples of such rotors are shown diagrammatically, and it is explained how the method has been applied at Birmingham to the production of high-speed beams of heavy atoms and molecules.

Rotating shutters for neutrons is the main application of rotational technique in the field of nuclear physics. Sectored disks of cadmium, which is highly opaque to very slow neutrons, were first used by Dunning and co-workers in 1935, but recent developments at the University of Chicago, as explained by Prof. Moon, have produced a 'sandwich' type of shutter composed of alternate layers of cadmium and aluminium enclosed in a strong steel shell which serves for the interruption of faster neutrons. Another shutter of this type consists of a slotted steel shaft rotating in front of a similar, coaxial, but fixed, shaft.

Finally, Prof. Moon's own particular application[2] of high-speed rotation in the field of nuclear physics is briefly described. A strong radioactive gold source of low mass is carried on the tip of a high-speed rotor, and by virtue of the Doppler effect sufficient energy is restored to the gamma radiation to produce resonant nuclear scattering in liquid mercury (10 per cent mercury-198).

[1] *J. Sci. Instr.*, **25**, 348 (1948).
[2] *Proc. Phys. Soc.*, A, **64**, 76 (1951).

THE MUTATION THEORY OF EVOLUTION

WHILE the majority of biologists agree that evolution proceeds by mutation and natural selection, Prof. L. P. Martin, of McGill University, suggests that the mutation–selection theory is not wholly convincing as a means of explaining natural evolution (*Amer. Sci.*, **41**, No. 1; January 1953). This dissent is not so much due to a failure to master the facts as to the grasp of some facts which Martin believes geneticists are apt to overlook.

None of the facts, nor all of them together, establishes the mutation–selection theory beyond all doubt.

Among the difficulties raised by Martin and his fellow recusants is that, though the occurrence of mutations in both wild and domestic populations is clearly established and though they are important in the genesis of our domestic breeds of animals and plants, even giving rise to some disease-resisting strains, yet all mutations seem to be in the nature of injuries which, to some extent, impair the fertility and viability of the affected organisms. The impaired stamina of present-day domestic breeds is shown by their inability to survive in natural conditions, except in exceptional and sheltered environments. Resistance to disease conferred by some mutations seems to be

illusory, for it is not a real or positive resistance but rather the removal of a host from an extremely narrow and specific range of susceptibility to a specific parasite. Lastly, the superior viability of a few mutations in an unusual environment is no evidence that they are not injuries, for injured organisms are sometimes more viable than normal ones in exceptional environments. In his experiments in 1944, for example, Leblond has shown that rats injured by thyroidectomy are more viable than normal rats in lowered oxygen pressures.

A truly progressive or 'beneficial' mutation must result in an improvement over the normal condition; but there is no clear evidence of the existence of such helpful mutations. In natural populations endless millions of small and great genic differences exist; but there is no evidence that they arose by mutation. All the available evidence tends to show that mutation is a pathological process which has had little or nothing to do with natural evolution, though mutations are extremely useful to man in his development of new domestic breeds. Nor is there convincing evidence that such a condition as a fully viable mutation ever occurs, while thousands of normal variations found in natural populations presumably arose by some as yet unknown and probably very subtle process; it is most unlikely that they arose by mutation.

While there is no doubt that species have evolved and that mutations and natural selection may be associated with the process, inferential evidence that the effects of long-continued over-use or disuse of a part can in time become hereditary is also impressive. Prof. Martin believes that the evidence for such inheritance is much stronger than is commonly realized, but that it is too often neglected or set aside from a mistaken notion that the mutation–selection theory offers a better established and less speculative explanation of all the known facts.

IDENTIFICATION OF FLAVONES BY THE ULTRA-VIOLET ABSORPTION SPECTRA OF THEIR IONS

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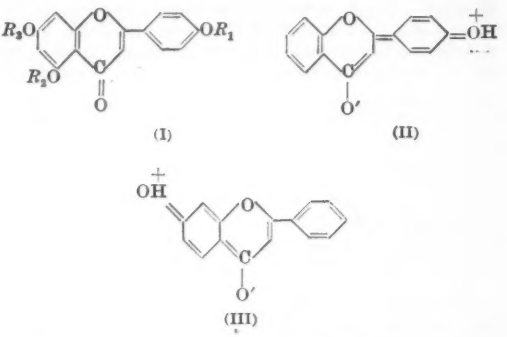
Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge, and Department of Scientific and Industrial Research

IT is well known that the ultra-violet absorption spectra of the ions of many polar-substituted compounds are markedly different from the spectra of the compounds themselves, usually the main band having shifted 20 mμ or more towards the red and increased in intensity. This fact has been used to a considerable extent in the study of the ionization of many weak acids and bases, including phenols[1]. However, so far as we are aware, no use has been made of these differences for identification purposes, although it is apparent from some of the data presented that certain polar compounds which have similar normal spectra may be differentiated by comparing the spectra of their ions (compare 4-*t*-butyl-2 : 6-dimethyl and 2 : 6-di-*t*-butyl-4-methyl phenol[1]).

In the case of compounds, such as the flavones, containing a number of similar polar groups, each group will contribute to the total bathochromic shift on ionization, and if one or more is blocked (for example, by methylation or glycosidation) the resulting shift should be substantially different. Since it has been shown that, except for flavonols and their 3-glycosides, the normal ultra-violet spectra of most flavone and flavonol glycosides are similar to those of the parent aglycone[2], it was felt that the spectra of the ions might afford an elegant method of differentiating such compounds which had been obtained in too small a quantity (for example, separation by paper chromatography[3,4]) for the normal chemical methods to be applied. From the results obtained, it is evident that the position of attachment of sugar in flavone glycosides can be determined from the spectra of the ions of either the compounds themselves, or the partial methyl ether of the corresponding aglycone obtained from them on a micro scale[4] by methylation and subsequent hydrolysis.



(I) (II)

(III)

The solubility of flavones in various alkaline media has been studied by Briggs and Locker[5], and it was apparent from their results and those of Coggeshall and Glessner[1] that the greatest differentiation of the spectra of the ions would be obtained at an alkali concentration below which complete ionization of all the phenolic hydroxyl groups took place. Although we have not as yet examined this point critically, we have found that 0·002 *M* sodium ethoxide in absolute ethanol is a suitable medium. The normal spectrum of the compound was first determined in absolute ethanol (2·5 ml.) using 1-cm. cells in a Hilger 'Uvispec' spectrophotometer over the range 220–450 mμ at 10-mμ intervals. Sodium ethoxide solution (0·5 ml. 0·012 *M*) was then added and the spectrum of the ion determined over the same wavelength interval. No attempt was made to determine accurately the position of the absorption maxima and minima or the molar extinction coefficient (ε), since the method has been envisaged specifically as a diagnostic one, and therefore devised to be as simple as possible in operation; but the spectra of the compounds themselves agree well enough with the published data[6] both in position and relative ε values of the absorption maxima. The $\lambda_{max.}$ quoted in Table 1 were obtained by interpolation, and the optical densities (*D*) are given as a percentage of

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Table 1. $\lambda_{max.}$ and Relative Optical Densities for Apigenin and its Derivatives in Ethanol and 0·002 *M* Sodium Ethoxide

Compound	Band I				Band II			
	Ethanol		0·002 *M* Sodium ethoxide		Ethanol		0·002 *M* Sodium ethoxide	
	$\lambda_{max.}$ (mμ)	$[D] = 100$	$\lambda_{max.}$ (mμ)	*D* as %* of $[D]$	$\lambda_{max.}$ (mμ)	*D* as % of $[D]$	$\lambda_{max.}$ (mμ)	*D* as %* of $[D]$
Apigenin	335	100	398	167	270	84	278 inflexion	111
,, 5 :7-dimethyl ether	327	100	380	148	259	69	262	62
,, 5 :4′-dimethyl ether	325	100	359	68	260	76	272	190
,, 7 :4′-dimethyl ether	325	100	†	—	271	92	292	114
,, 7-glucoside	335	100	398	148	268	87	269	82
,, 4′-glucoside	334	100	391	107	270	102	275	123

* Corrected for volume increase.
† There is an indication of an inflexion at $\lambda = 370$ (see graph).

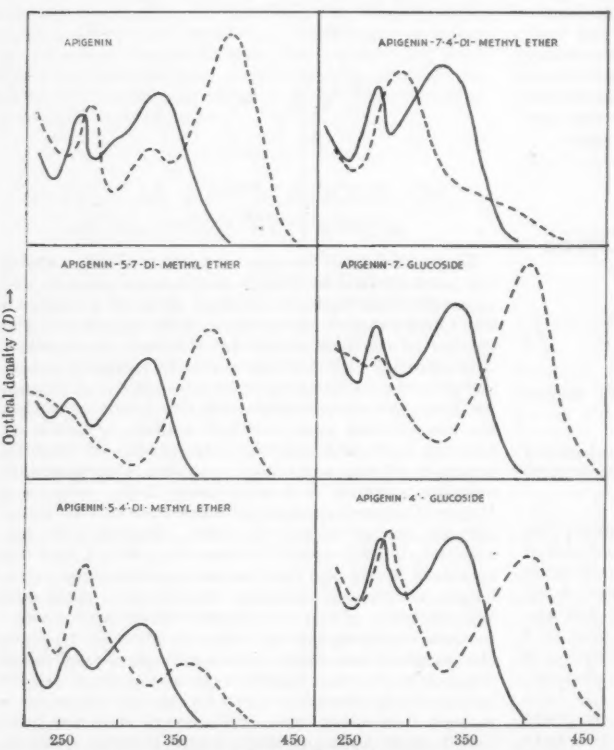
that for the main absorption peak. The concentrations were chosen so that the maximum optical density was less than 1·0, where secondary radiation due to fluorescence can be ignored[7].

A consideration of the spectra of more than forty synthetic free and partially methylated flavones and flavonols has shown many interesting regularities, the most notable of which is the difference in the contribution to the alkali shift made by the 5-, 7-, and 4′-hydroxyl groups in the flavone nucleus. These differences may best be illustrated by reference to apigenin (5 : 7 : 4′-trihydroxyflavone; formula I, R_1, R_2, R_3 = H) and its derivatives (see Table 1 and graphs). The normal spectra of apigenin and its 5 : 7-, 5 : 4′- and 7 : 4′-dimethyl ethers (formula I, R_1 = H, R_2, R_3 = Me; R_2 = H, R_1, R_3 = Me; R_3 = H, R_1, R_2 = Me) are similar. The spectral shift of the dimethyl ethers in alkali is notably different both in amount ($\Delta\lambda$) and in relative intensity (ΔD per cent). For band I (*c.* 330 mμ), the 5 : 7-dimethyl ether has the largest shift ($\Delta\lambda = 53$ mμ) and the intensity of the band is also increased (ΔD per cent = 48), whereas with the 5 : 4′-dimethyl ether, although the spectrum shows a distinct change, the shift is less ($\Delta\lambda = 34$ mμ) and the band has a reduced intensity (ΔD per cent = − 32). For the 7 : 4′-dimethyl ether, band I is almost completely suppressed, possibly due to the strong hydrogen bonding of the 5-hydroxyl group with the neighbouring oxygen at C_4, as manifested by difficulty of methylation and paper chromatographic studies[8]. For band II (*c.* 270 mμ) the 5 : 7- and 5 : 4′-dimethyl ether have the opposite behaviour to that shown for band I, the former compound having a relatively small shift and reduced intensity, whereas the latter has a larger shift and greatly increased intensity. The 7 : 4′-dimethyl ether has an even larger shift than the 5 : 4′-ether, but in this case the increase in intensity is much smaller (Table 2). The differences between the changes in band I for the compound having a free 4′-hydroxyl group and that having a free 7-group is probably due to the extended conjugation of the former as shown by formulæ II and III, and is given by all the compounds we have studied.

Table 2. Alkaline Shift ($\Delta\lambda$) and Relative Optical Density Changes (ΔD) for Apigenin and its Derivatives on Changing from Ethanol to 0·002 *M* Sodium Ethoxide

Compound	Band I		Band II	
	$\Delta\lambda$ (mμ)	ΔD%	$\Delta\lambda$ (mμ)	ΔD%*
Apigenin	63	+67	8	+32
,, 5 : 7-dimethyl ether	53	+48	+3†	−10
,, 5 : 4′-dimethyl ether	34	−32	+12	+150
,, 7 : 4′-dimethyl ether	—	—	+21	+23
,, 7-glucoside	63	+48	+1	−5
,, 4′-glucoside	57	+7	+5	+21

* Calculated on the basis of *D* for Band II in ethanol = 100 per cent.
† To inflexion.



——, Spectra in absolute ethanol; – – –, spectra in 0·002 *M* sodium ethoxide (uncorrected for volume increase)

The spectra of two apigenin monoglucosides have also been compared. The first was obtained from the partial hydrolysis of apiin, purified by paper

chromatography[4], and is undoubtedly the 7-glucoside (formula I, R_1 = glucosyl; R_1, R_2 = H). The second was obtained from the petals of a variety of *Dahlia variabilis*[5] and appears to be 4′-glucosyl-apigenin (formula I, R = glucosyl, R_2, R_2 = H). These compounds had different R_F values (7-, 0·56; 4′-, 0·52) in butanol–water, and the 7-glucoside had a distinctly more yellow fluorescence than the 4′-compound in ultra-violet light when fumed with ammonia. The spectra obtained from these compounds (see Table 1 and graphs) show that they exhibit similar behaviour to the corresponding dimethyl ethers. The differences in alkali shift ($\Delta\lambda$) and relative intensities (ΔD per cent) are, however, not so great as with the ethers but follow the same order (Table 2). Nevertheless, it can be seen from the graphs that the two glucosides are readily distinguished by the spectra of their ions in sodium ethoxide solution.

Similar effects have been obtained with other glycosides, and these results and application of the method to reflectance-spectra on filter paper will be published in full elsewhere.

We wish to thank Dr. T. H. Simpson, of the Torry Research Station, Aberdeen, and Dr. W. D. Ollis, University of Bristol, for gifts of synthetic and natural flavone derivatives. We also wish to thank Dr. T. White, the Forestal Central Laboratory, Harpenden, for his helpful advice.

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[1] Coggeshall, N. D., and Glessner, jun., A. S., *J. Amer. Chem. Soc.*, 71, 3150 (1949).
[2] Tasaki, T., *Acta Phytochim.*, **2**, 129 (1925).
[3] Bate-Smith, E. C., Biochem. Symp. No. 3, 62 (1949).
[4] Nordström, C. G., Swain, T., and Hamblin, A. J., *Chem. and Indust.* [85 (1953)].
[5] Briggs, L. H., and Locker, R. H., *J. Chem. Soc.*, 3136 (1951).
[6] Skarzynski, B., *Biochem. Z.*, **301**, 150 (1939).
[7] Braude, E. C., Fawcett, J. S., and Timmons, C. J., *J. Chem. Soc.*, 1019 (1950).
[8] Simpson, T. H., and Garden, L., *J. Chem. Soc.* [4638 (1952)].
[9] Nordström, C. G., and Swain, T., *J. Chem. Soc.* (in the press).

LIGNIN CHEMISTRY AND THE TAXONOMY OF HIGHER PLANTS

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IT has been known for more than fifty years[1] that the woods of dicotyledons in general give a positive Mäule reaction (a rose-red colour when treated successively with aqueous potassium permanganate, hydrochloric acid and ammonia), while those of conifers in general give a negative test (a brownish or orange colour without a trace of red). In 1941 or 1942 a chance remark by the late Dr. Harold Hibbert, that following alkaline nitrobenzene oxidation he was getting syringaldehyde and vanillin from the lignin of maple but vanillin only from that of spruce, led one of us (R. D. G.) to suggest that a positive Mäule reaction is due to the presence of the syringyl group. (We learned later that Campbell *et al.*[2-4] had shown that the chlorine-sodium sulphite colour reaction of woody tissues seems to be due to a syringyl or similar grouping.) This suggestion was followed up and the results of these investigations published by Creighton, Gibbs and Hibbert in 1944[5]. A wide selection of vascular plants were tested by the Mäule technique and more than fifty selected species were then subjected to alkaline nitrobenzene oxidation. The aldehydes were separated by fractional sublimation. In each case it was possible to isolate syringaldehyde and vanillin from species giving a positive Mäule reaction, while vanillin only was obtained from those giving a negative reaction.

Dicotyledons in general gave syringaldehyde/vanillin (S/V) values of about 3, but there were interesting exceptions. Thus the lignins of the supposedly primitive dicotyledons *Belliolum haplopus* and *Zygogynum vieillardi* gave values of little more than 1. Conifers in general, negative to Mäule's test, yielded no syringaldehyde; but about a dozen species of *Podocarpus* gave faint to strong positive Mäule tests (Crocker[6] had previously found one species of *Podocarpus* to give a positive Mäule test), and those giving a strong positive reaction had S/V values of about 1. Particularly interesting was the case of *Tetraclinis articulata*. This monotypic genus of the Cupressaceæ, separated by Masters[7] from *Widdringtonia* and *Callitris* by 'traditional' taxonomic methods, was found to be sharply set aside from other members of the Cupressaceæ in that it gave a strong positive Mäule test and an S/V value of 0·8. Masters's separation was thus upheld by chemical analysis, and one of us (R. D. G.) has brought together other chemical evidence pointing in the same direction[8]. The three genera of the Gnetales (*Ephedra*, *Welwitschia* and *Gnetum*) were also found to give positive Mäule tests —extending the findings of Schindler[9]—and to yield both syringaldehyde and vanillin. Monocotyledons gave both syringaldehyde and vanillin (and gave a positive Mäule test), while three species yielded also some *p*-hydroxybenzaldehyde.

The results of these investigations appeared in 1944, but it was clear that further work on the possible application of lignin analyses to taxonomy was desirable. In the first place, it seemed worth while to determine whether or not *p*-hydroxybenzaldehyde is restricted to monocotyledons (and among them perhaps to grasses) as the results (in ref. 5) might suggest; to see if all the supposedly primitive dicotyledons have low S/V values; and to look for unusual or suggestive ratios which might throw light upon plant relationships. The method used by Creighton *et al.* is slow and requires rather large amounts of plant material (about 50 gm.). It was therefore of the greatest interest to learn from Stone (to whom our thanks are due) of a new micromethod using paper chromatography to separate and estimate the aldehydes resulting from the alkaline nitrobenzene oxidation of small amounts (40–100 mgm.) of woody material. A description of the method, used in the present work, has now been published by Stone and Blundell[10].

Qualitative results are summarized in Table 1. It is obvious that *p*-hydroxybenzaldehyde is far from restricted in its occurrence. It has been found in *Psilotum*, in several lycopsids, in *Equisetum*, in a fern, in a cycad, in several conifers, and in all the monocotyledons examined. It appears to be absent, in general, from dicotyledons (present in *Tetracentron sinense* but absent from its probable relative *Trochodendron*). In *Isoëtes* there seems to be a lack of

* Now holder of a Lalor Foundation Fellowship at Cornell University. This paper reports in part work submitted as partial fulfilment of the requirements for the degree of Master of Science (Botany) at McGill University.

Table 1. Qualitative results—Mäule's test and aldehydes from lignins

Species	Mäule's test	Syringaldehyde	Vanillin	*p*-Hydroxybenzaldehyde
Marchantia sp.	–	–	–	–
Funaria hygrometrica (L.) Sibth.	–	–	–	–
Psilotum triquetrum Sw.	–	–	+	+
Lycopodium complanatum L.	–	–	+	+
Selaginella (3 spp.)	+	+	+	+
Isoetes muricata Dur.	–	+	+	+
Equisetum hyemale L.	–	–	+	+
Cibotium sp.	–	–	+	+
Stangeria paradoxa T. Moore	+	+	+	+
Picea glauca (Moench) Voss	–	–	+	+
Larix sp.	–	–	+	+
Araucaria (2 spp.)	–	–	+	+
Agathis vitiensis (Seem.) Warb.	–	–	+	+
Podocarpus spinulosus R.Br.	–	–	+	+
,, *elatus* R.Br.	+	+	+	+
Typha latifolia L.	+	+	+	+
Pontederia cordata L.	+	+	+	+
Bambusa tulda Roxb. ?	+	+	+	+
Scirpus atrovirens Willd. v. *georgianus* (Harper) Fern.	+	+	+	+
Carex vesicaria L.	+	+	+	+
Salix sp.	+	+	+	–
Magnolia (2 spp.)	+	+	+	–
Cercidiphyllum japonicum Sieb. and Zucc.	+	+	+	–
Trochodendron dralioides Sieb. and Zucc.	+	+	+	–
Tetracentron sinense Oliv.	+	+	+	+
Zygogynum bailloni v. Tiegh.	+	+	+	–
Pseudowintera axillaris v. *colorata* (Raoul) A. C. Smith	+	+	+	–
Degeneria vitiensis Bailey and Smith	+	+	+	–
Atherosperma moschatum Labill	+	+	+	–
Euphorbia schimperi Presl.	+	+	+	–
Acer (9 spp.)	+	+	+	–

spp.); 'quantitative' Mäule tests (29 spp.); reaction with the hydrochloric acid/methanol reagent of Isenberg and Buchanan[12] which seems to indicate catechol tannins[13] (51 spp.); reaction to Gorter's test[14] which is supposed to indicate caffeic and/or chlorogenic acid(s) (16 spp.); presence or absence of quebrachitol as recorded by Plouvier[15] (6 spp.); and iron and manganese values as determined by Riou and Delorme[16] (6 spp.).

We find that S/V values are usually high in *Acer* proper (averaging 2·0 for 14 spp.); low in the *Negundo* group (0·5 for *A. cissifolium* and *A. negundo*, 0·6 for *A. henryi*) and in *Dipteronia* (1·0 in *D. dyeriana*, 0·3 in *D. sinensis*). 'Quantitative' Mäule tests (in which depth of colour from weak to strong is indicated by values 1 to 3) roughly parallel the S/V values. Most true maples give a strong hydrochloric acid/methanol reaction, while the *Negundo* group gives no, or a very weak, reaction. *Dipteronia* gives a deep colour with this reagent. The results from Gorter's test suggest that the family as a whole lacks caffeic and/or chlorogenic acid(s), while Plouvier's observations indicate the probable general occurrence of quebrachitol. Finally, we have learned that Riou and Delorme have found that *Acer negundo* differs strikingly in manganese content and slightly in iron content from our five local species of *Acer* (Table 2).

We believe that the *Negundo* group differs sufficiently from the other species of *Acer* to be set aside from them, thus reviving Moench's old genus *Negundo*. Further work, which is proceeding, may determine if this separation is justified.

Table 2. Iron and manganese values of *Acer* spp. (from data of Riou and Delorme)

Species	Manganese (p.p.m. dry wt.)					Iron (p.p.m. dry wt.)				
	Bark	Sap wood	Heart wood	Twigs	Leaves	Bark	Sap wood	Heart wood	Twigs	Leaves
A. saccharum	262	59	55	170	220	86	27	18	55	179
A. pennsylvanicum	252	48	70	148	175	61	10	12	47	142
A. rubrum	270	46	55	48	301	53	14	19	41	125
A. saccharinum	190	20	22	77	144	100	12	18	40	181
A. spicatum	128	12	18	69	83	91	12	17	57	191
A. negundo	39	0	0	20	38	195	13	20	56	238

correlation as between the Mäule test and the presence of syringaldehyde; but lignin quantities here are small, and careful reinvestigation would seem to be desirable.

Since results from 'primitive' dicotyledons are disappointingly variable, further work is required, and one of us (R. D. G.) is investigating other aspects of the chemistry of the Magnoliales (in the sense of Gundersen[11]), an order which includes these plants.

As an example of the 'unusual or suggestive ratios' referred to above we may take those met with in the Aceraceæ. This relatively small family is usually considered to have but two genera: *Acer* (Tourn.) L. with perhaps 150 spp., and *Dipteronia* Oliv. with 2 spp. A third genus, *Negundo* Moench, is sometimes 'made' to include about four of the species of *Acer*.

To date we have accumulated data pertaining to about one-third of the known species of *Acer* (including the *Negundo* group) and to the two species of *Dipteronia*. Data obtained include S/V ratios (19

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[1] Mäule, C., "Funfstück's Beiträge zur wiss. Botanik", **4**, 166 (1900).
[2] Campbell, W. G., Bryant, S. A., and Swann, G., *Biochem. J.*, **31**, 1285 (1937).
[3] Campbell, W. G., McGowan, J. C., and Bryant, S. A., *Biochem. J.*, **32**, 2138 (1938).
[4] Campbell, W. G., and McGowan, J. C., *Nature*, **143**, 1022 (1939).
[5] Creighton, R. H. J., Gibbs, R. Darnley, and Hibbert, Harold, *J. Amer. Chem. Soc.*, **66**, 32 (1944).
[6] Crocker, E. C., *Bot. Gaz.*, **95**, 168 (1933–34).
[7] Masters, M. T., *J. Linn. Soc. Lond.* (Botany), **30**, 1 (1895).
[8] Gibbs, R. Darnley, *Trans. Roy. Soc. Can.*, Ser. 3, Sect. V., **39**, 71 (1945).
[9] Schindler, H., *Z. wiss. Mikroskopie*, **48**, 289 (1931).
[10] Stone, J. E., and Blundell, M. J., *Anal. Chem.*, **23**, 771 (1951).
[11] Gundersen, A., "Families of Dicotyledons" (Waltham, Mass., 1950).
[12] Isenberg, I. H., and Buchanan, M. A., *J. Forest.*, **43**, 888 (1945).
[13] Adler, E., *Svensk Papperstidning*, **54**, 445 (1951).
[14] Gorter, K., *Archiv. Pharm.*, **247**, 184 (1909).
[15] Plouvier, V., *C.R. Acad. Sci.* (Paris), **224**, 1842 (1947).
[16] Riou, P., and Delorme, G., *Nat. Canadien.*, **67**, 87 (1940).

LETTERS TO THE EDITORS

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Structure of Insulin as indicated by Atomic Models

THE molecule of insulin consists of polypeptide chains of two kinds linked together by cystine residues. The complete amino sequence in these chains is now known, thanks to the work of Sanger and his co-workers[1]. The *A* chains of Sanger's acid fraction contain twenty-one residues and the *B* chain thirty residues. There are four half-cystine residues in the *A* chains and two in each of the *B* chains, and their positions in the residue sequence are *A*6, *A*7, *A*11, *A*20 and *B*7, *B*19. The minimum molecular weight has generally been reported to be about 12,000; but recently a value of the order of 6,000 has also been put forward. If the former value is correct, there will be two *A* and two *B* chains in the molecule, while there can only be one of each if the latter value is confirmed. It follows that if the linking arrangement could be determined, the complete chemical structure of this protein molecule would be known. There are many conceivable ways of linking the chains together and in the case of four chains there are some hundreds. It would be a considerable advance towards determining the complete structure if all those which are sterically impossible could be eliminated.

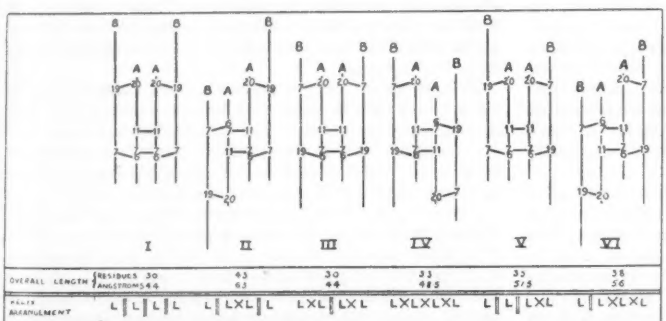
In what follows, we shall describe all the structures based on the Pauling 3·7 residue helix (thirteen-membered ring)[2] which have been found sterically possible as the result of using suitably constructed space-filling atomic models[3]. In deducing these structures, all possible combinations of left- and right-hand helices were considered. Since the polypeptide fold in this molecule may be something other than the Pauling helix, it is possible that not one of these structures is the correct one for insulin; but at least the field for further investigation has been considerably reduced.

When arranging the models, the helices were only allowed to bend to the small extent which was possible without breaking hydrogen bonds. It was found that no intra-chain link could be formed. Since an intra-chain link would have to be formed in any two-chain structure, it follows that either the two-chain structure is impossible or that the Pauling helix cannot be the basis of the structure. It remained, therefore, to investigate the four-chain structures.

It was shown that three links could not be formed between the two *A* chains. Some structures in which each *B* chain could be linked to both *A* chains could be built, but none of these allowed the chains to lie parallel (as indicated by the X-ray evidence[4]) or the molecule to take up a planar configuration (surface chemistry evidence points to a molecule 7–9 A. thick[5], which is much less than the thickness of two helices) and were not, therefore, further considered.

There remain those arrangements in which each *B* chain is attached by two links to one *A* chain. Each half of the molecule will contain one *A* and one *B* chain, and we shall first discuss how these can be linked together. It was found impossible to form the two links between an *A* and a *B* chain if one chain was wound into a left-hand helix and the other into a right. Therefore the half-molecule must contain *like* helices (both left-handed or both right-handed). There are then six possibilities of constructing half-molecules in which the links are: (1) *B*7–*A*7, *B*19–*A*20; (2) *B*7–*A*20, *B*19–*A*7; (3) *B*7–*A*11, *B*19–*A*20; (4) *B*7–*A*20, *B*19–*A*11; (5) *B*7–*A*6, *B*19–*A*20; and (6) *B*7–*A*20, *B*19–*A*6. With the first four of these arrangements, however, attachment to another half-molecule was found sterically impossible, so that it would seem that the acceptable structures must be based on the half-molecules (5) or (6), or a combination of the two (in the half-molecule (5) the chains are parallel, whereas in (6) they are anti-parallel). By combining these half-molecules in all possible ways, we obtain six molecular structures in which the four helices are all right- or all left-handed, and six in which one half-molecule has left-hand helices and the other right-hand helices. These are shown in the diagram, where the numbers refer to the positions of the half-cystines in the residue sequence. Opposite 'helix arrangement' is given the kind of helix (*L* or *R* for left- or right-hand) and the arrangement of the helices (‖ or × indicating whether the adjacent helices are parallel or anti-parallel to one another). It was found possible to build all these six structures and attach all the side-chains in the correct sequence.

The third residue from the end of each *B* chain is a proline residue. It was found that this will fit on to a right-hand helix, but calls for a re-arrangement of neighbouring parts of the chain before it can be fitted to a left-hand helix. (The convention used in building the model corresponded to what is now known to be the absolute configuration of an L-polypeptide[6]. With a D-polypeptide the proline would fit a left-hand helix.) Riley and Arndt[7] have suggested that this might be decisive in making the *B* chain a right-hand helix. Since we have shown with the models that the two helices in a half-molecule must be either both right- or both left-handed, it would follow from their suggestion that all four chains in the molecule could only be right-hand helices, and the possible structures would be reduced to six. It is, however, far from certain that one proline residue so near the end of the chain could be decisive in this respect.



It was shown that all twelve structures could be pulled into a β-configuration of four fully extended chains, which was consistent with the finding that insulin could, at least in part, undergo a reversible α ⇌ β transformation[6]. To demonstrate this convincingly with so large a molecule, it was necessary to concentrate attention on the small ring which includes the two *A*7 and two *A*11 half-cystine residues.

Finally, it was also found possible to show that each of these structures could be fitted into the unit cell deduced by Barbara Low[4] for acid insulin sulphate, so as to be consistent with the symmetry requirements. Particulars of this will be published elsewhere in a more detailed account of this investigation.

Thanks are due to Dr. C. H. Bamford and Dr. H. Tompa for their advice on relating the structures to the unit cell, and to Mr. J. E. Goodwin for his assistance with the building and manipulation of the models.

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[1] Sanger, F., and Tuppy, H., *Biochem. J.*, **49**, 463 (1951). Sanger, F., and Thompson, E. O. P., *Biochem. J.*, **53**, 366 (1953).
[2] Pauling, L., Corey, R. B., and Branson, H. R., *Proc. U.S. Nat. Acad. Sci.*, **37**, 205 (1951). Pauling, L., and Corey, R. B., *Proc. U.S. Nat. Acad. Sci.*, **37**, 235 (1951).
[3] Hartley, G. S., and Robinson, C., *Trans. Farad. Soc.*, **48**, 847 (1952). Robinson, C., and Ambrose, E. J., *Trans. Farad. Soc.*, **48**, 854 (1952).
[4] Low, B. W., *Nature*, **169**, 955 (1952).
[5] Rothen, A., Chow, B. F., Greep, R. O., and van Dyke, H. B., Cold Spring Harbor Symp. Quant. Biol., **9**, 272 (1941).
[6] Kuhn, W., *Z. Elektrochem.*, **56**, 506 (1952).
[7] Riley, D. P., and Arndt, U. W., *Nature*, **171**, 144 (1953).
[8] Elliott, A., Ambrose, E. J., and Robinson, C., *Nature*, **166**, 194 (1950).

Polysaccharides associated with Alpha-Cellulose

Alpha-cellulose is an insoluble fibrous residue obtained by extraction of wood, straw pulps and holocelluloses with strong alkali under carefully controlled conditions. Since the procedures used are arbitrary, the yield and composition of the alpha-cellulose prepared from any specific source may vary within rather narrow limits. Although alpha-cellulose from structural celluloses consists largely of β-1,4 glucopyranose chains, it contains also some non-glucose units. Xylan appears to be associated with most alpha-celluloses, with mannan being present also in those from gymnosperms[1,2]. Recent evidence by Leech[3] indicates that a chemical union exists between the glucose and mannose units. Analytical data on wood alpha-celluloses suggest that uronic acid residues are also contained in the alpha-cellulose fraction, although positive identification of the specific acid has not been made[2].

Chromatographic methods for the separation of sugars provide an excellent means of examining the polysaccharides associated with alpha-celluloses. Our observation that 'xylan' of wheat straw has L-arabinose and D-glucuronic acid units attached to the xylan chain[4,5] led to investigation of the 'xylan' material in various alpha-celluloses prepared from cereal straw holocellulose and wood pulps.

Extractive-free wheat, oat and barley straw and jute fibre were converted to holocellulose by treatment with acid chlorite[6]. Alpha-cellulose was prepared from these holocelluloses, and from purified cotton linters and wood pulps (hardwood and softwood) by the standard 17·5 per cent alkali treatment[7]. 1-gm. samples of each of the alpha-celluloses were hydrolysed according to the usual Klason lignin analysis procedure[8]. Removal of acid with barium carbonate provided solutions of the simple sugars produced by hydrolysis. Glucose was oxidized preferentially by incubation for 18 hr. with 'Deoxygenase' (a commercial glucose oxidase preparation). The solutions were clarified by centrifuging and concentrated to a small volume. Paper chromatography of the sugar solutions after removal of the glucose permitted small amounts of other sugars to be readily detected. Removal of inorganic salts (introduced as buffers in the enzymatic oxidation) by ion exchange resins was required before chromatography of the sugars only in the cases of the wood pulps. The results of quantitative chromatographic analysis are given in the accompanying table.

Composition of Alpha-Cellulose

Sample	D-Xylose (%)	L-Arabinose (%)	D-Mannose (%)	Uronic acid anhydride (%) ($CO_2 \times 4$)
Sulphite pulp (softwood)	0·47	nil	1·30	1·32
Sulphite pulp (hardwood)	0·33	0·08	nil	1·00
Wheat straw	5·48	3·27	nil	2·52
Jute straw	5·53	4·19	nil	3·68
Barley straw	3·86	5·79	nil	3·34
Oat straw	1·86	4·71	nil	3·20
Cotton fibre	nil	nil	nil	1·34

Both D-xylose and L-arabinose were found in the hydrolysates of cereal straw alpha-celluloses. So far as we are aware, the presence of L-arabinose in alpha-cellulose hydrolysates has not been reported previously. In barley and oat alpha-cellulose, the L-arabinose content exceeded that of D-xylose. The finding of pentosan material in the alpha-cellulose from jute chlorite holocellulose is contrary to the results reported by Sarkar, Mazumdar and Pal[9]. Since these workers did not remove D-glucose prior to chromatographing their solutions, the small amounts of other sugars were probably obscured. L-Arabinose units were detected in the alpha-cellulose of hardwood pulp, but no D-mannose was found. The softwood pulp alpha-cellulose yielded both D-mannose and D-xylose, in agreement with the observations of Lewis *et al.*[2]. The acid conditions used for preparation of the wood sulphite pulps may account in part for the relatively small amount of pentose sugars found in their alpha-celluloses. Cotton alpha-cellulose, which is a β-1,4 polyglucosan, yielded only D-glucose.

The presence of uronic acid in alpha-cellulose of straws and jute is suggested from the analytical data shown in the table. The naphthoresorcinol test on the hydrolysates was positive, although no uronic acid could be detected on the chromatograms. Proof of the presence of uronic acid units must await more rigorous methods of identification. Cotton and the pulp alpha-celluloses are considered free from uronic acids. The presence of L-arabinose in addition to D-xylose, and the possible presence of uronic acid units, suggest that the same polyuronide hemicellulose found in wheat straw holocellulose[4] may be associated with straw alpha-celluloses.

Whether the non-glucose constituents found in alpha-cellulose are chemically joined to the cellulose

molecule or are only physically associated as envisaged in the cellulosan of Hawley and Norman[10] is not known.

We wish to thank the following commercial organizations: Industrial Cellulose Research, Ltd., Hawkesbury, Ontario, for the wood pulps; Indian Jute Mills Association, Baltic House, London, England, for supply of a sample of jute; and Takamine Laboratory, Clifton, New Jersey, for a generous sample of 'Deoxygenase'.

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[1] Wise, L. E., and Ratcliff, Evelyn K., *Anal. Chem.*, **19**, 459 (1947).
[2] Lewis, H. F., Wise, L. E., and Browning, B. L., *TAPPI*, **33**, 92 (1950).
[3] Leech, J. G., *TAPPI*, **35**, 249 (1952).
[4] Adams, G. A., *Can. J. Chem.*, **30**, 698 (1952).
[5] Bishop, C. T., *Can. J. Chem.*, [**31**, 134 (1953)].
[6] Adams, G. A., and Castagne, A. E., *Can. J. Res.*, B, **26**, 325 (1948).
[7] Ritter, G. J., *Indust. Eng. Chem., Anal. Edit.*, **1**, 53 (1929).
[8] Ritter, G. J., Seborg, R. M., and Mitchell, R. L., *Indust. Eng. Chem., Anal. Edit.*, **4**, 202 (1932).
[9] Sarkar, P. B., Mazumdar, A. K., and Pal, K. B., *Nature*, **165**, 897 (1950).
[10] Hawley, L. F., and Norman, A. G., *Indust. Eng. Chem.*, **24**, 1190 (1932).

Action of Thionyl Chloride on Carboxylic Acids in Presence of Pyridine

In order to use thionyl chloride most effectively for the preparation of acyl chloride, *R*CO.Cl, a knowledge of the sequence of reactions occurring is desirable. Trichloroacetic acid reacts extremely slowly with thionyl chloride even at higher temperatures; but Carré and Libermann[1] have shown that pyridine (1 mol.) helps the reaction. Mills and Human[2] adopted the use of the base in the preparation of anilides and esters of the half-esters of phthalic acid. We have now shown that during the addition of the first half of the thionyl chloride (1 mol.) to an ethereal solution of *cyclo*hexyl hydrogen phthalate (1 mol.) and pyridine (1 mol.), the following reactions occur:

$$R.CO_2H,NC_5H_5 + SOCl_2 \rightarrow R.COCl + C_5H_5NHOSOCl$$
$$R.CO_2H,NC_5H_5 + R.COCl \rightarrow (R.CO)_2O + C_5H_5NHCl$$

The second half of the thionyl chloride then converts the anhydride into the acyl chloride, and it was from the latter that Mills and Human obtained the anilide by adding the amine together with pyridine. Now the significant point is that although the formation of anhydride is very rapid[3], the formation of acyl chloride from the anhydride is comparatively slow and requires a time which depends on the nature of *R* in the acyl group. It just happens that the anhydride of *cyclo*hexyl hydrogen phthalate (the example quoted by Mills and Human) will give acyl chloride in yields approaching 80 per cent in the one hour of reaction time allowed by these workers; but the rate of formation of acyl chloride from the anhydride of 2-octyl hydrogen phthalate is definitely slower, and we were at a loss to account for the high yield of anilide reported by Mills and Human.

It appeared possible that the anhydride itself was giving the anilide; but in this case this reaction would have to compete with a very quick interaction of the amine with thionyl chloride remaining.

Trichloroacetic acid is a special case[3]. The acyl chloride is formed directly from the acid by the addition of thionyl chloride (1 mol.) to the acid (1 mol.) and pyridine (1 mol.), and the acyl chloride does not react with the acid to give the anhydride.

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[1] Carré and Libermann, *C.R. Acad. Sci., Paris*, **199**, 1422 (1934).
[2] Mills and Human, *Nature*, **158**, 877 (1946).
[3] Gerrard and Thrush, *J. Chem. Soc.*, 741 (1952); and unpublished work.

Use of the Warburg Apparatus in Soil Metabolism Studies

Methods so far used for studying the evolution of carbon dioxide resulting from the decomposition of soil organic matter[1], although satisfactory for periods of 24 hr. or more, do not permit measurements for shorter periods, which may be important in studying the immediate effects of soil treatments.

It seemed that the Warburg respirometer had possibilities in this regard. Other workers[2] have, in fact, used it to study the respiration of suspensions of non-soil organisms added with excess substrate to soils at various moisture-levels, in order to assess aeration conditions in the soil. In these studies, however, the respiration of the soil population itself was not closely followed, and no attempt was made to relate respiration to the decomposition of soil organic matter.

The application of the Warburg apparatus to the study of soil metabolism has the particular advantages that respiration can be accurately measured over short periods, respiratory quotients obtained and the immediate effects of substrate or inhibitor studied by addition from the side arm of flask.

Although the purpose of the present communication is chiefly to direct attention to its possibilities, it is of interest to note some points that have become apparent.

Table 1. Response of the Soil Population to Amelioration

Soil	Gas	Microlitres of gas per gm. of soil after 1	2	3	4	5	6	7 hr.
(*a*) Untreated soil *p*H 4·8	O_2	9	21	34	46	58	72	86
	CO_2	8	20	33	47	60	75	89
(*b*) Soil with $Ca(OH)_2$ to *p*H 6·7	O_2	15	26	40	52	72	88	105
	CO_2	17	30	45	57	73	88	102

The soil from which the results in Table 1 were obtained had been stored in an air-dry condition for ten weeks before use, and respiration studies commenced within an hour of wetting. It is interesting to note the short duration of any lag period in the development of respiration. Note, too, the immediate increase in respiration-rate on raising the *p*H with calcium hydroxide. Both results suggest the existence of a soil population in a relatively resting or inhibited state, able to respond without significant multiplication or adaptation to improved moisture or *p*H relationships.

Subsequent decline in the respiration-rate after several days with moisture-level constant suggests that some part of the soil organic matter is in a more readily decomposable form after the soil has been air-dry for a period.

Table 2. Effect of Moisture Content on Respiration

Moisture content of soil	Respiration (μl.) after 8 hr. Oxygen uptake	Carbon dioxide evolved	R.Q.
100%—saturated	22	72	3·1
60% (water holding capacity)	145	147	1·0
48% (field capacity)	125	100	0·8
24%	65	60	0·9
5% (air-dry)	0	0	

Table 2 shows that the activity of the soil micro-organisms in this sample of soil was at a maximum above field capacity but was less in the saturated soil. Webley[3], using yeast cells suspended on soils of different moisture-content, found a similar decline in respiration above an optimum moisture-level, and demonstrated that this was due to a reduction in the availability of oxygen. The results obtained indicate a similar behaviour by the normal soil population, and there is a relationship between soil moisture and overall metabolism as indicated by the respiratory quotient.

The effect of particular added substrates can also be investigated by this method. A more detailed account will be published elsewhere.

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[1] Waksman and Starkey, *Soil Sci.*, **17**, 141 (1924). Jensen, *Proc. Linn. Soc., N.S.W.*, **61**, 22 (1936). Vandecaveye and Katznelson, *Soil Sci.*, **46**, 139 (1938).

[2] Quastel and Webley, *J. Agric. Sci.*, **37**, 257 (1947). Ellinger and Quastel, *Biochem. J.*, **42**, 214 (1948).

[3] Webley, *J. Agric. Sci.*, **37**, 249 (1947).

A Microgasometric Procedure

In experiments now being carried out on the X-ray induced decomposition of azides, we have found it necessary to develop a simple method for measuring small volumes of gas (of the order of several cubic millimetres) evolved when a crystal (generally weighing one or two milligrams) dissolves in water. The method may have applications to other problems.

One or two square cover-slips are cemented on to each end of a microscope slide so as to form raised steps. A thin glass plate (this should be thicker than a cover-slip, in order to prevent bending under surface-tension forces) can be placed across these steps, so that a narrow space (0·3 mm. thick in our apparatus) is left between it and the central part of the microscope slide. The solid sample is placed in the middle of this central area and covered with the glass plate. From a pipette a quantity of water, pre-determined to be just sufficient to fill the space between the slide and the glass plate, is then squirted quickly into this space. The space fills before any appreciable amount of the sample dissolves. As dissolution takes place, the evolved gas forms bubbles between the slide and glass plate. By tilting the slide it is not difficult to induce the bubbles to coalesce to a single circular bubble. The diameter of this is then measured with a travelling microscope, the figure giving, in conjunction with the thickness of the space, the volume of gas. The solution can then be washed off the slide and glass plate, to be analysed in order to determine the amount of the sample, if this is not already known.

The effect of surface tension on the pressure within the bubble is difficult to correct for under practical conditions, but is not significant when an accuracy of the order of 2 or 3 per cent is aimed at.

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Arginine and Deoxyribonucleic Acid Content of Erythrocyte Nuclei and Sperms of some Species of Fishes

The importance of arginine as a component of the chromatin in nuclei has been known for a long time. This amino-acid has even been considered as a possible 'bond' between the deoxyribonucleic acid (DNA) and the protein because it is so characteristic of all nucleoproteins. If it is so, there should be a relationship between individual amounts of the acid and of arginine in nuclei—provided that nuclei contain no arginine additional to that linked to deoxyribonucleic acid. We have therefore studied the individual amounts of arginine in some nuclei and sperms, compared with the nucleic acid content in the same material.

Material and methods. We worked with seven species of fishes; we used erythrocytes of tench, pike, roach and perch, in which the amount of deoxyribonucleic acid per nucleus is common to a number of fish, and trout, carp and barbel, in which this value is markedly higher[1]. For comparison we used the erythrocyte nucleus of a bird (domestic fowl) and the thymus nucleus of a mammal (calf). We assume that the amount of arginine found in the whole erythrocyte nucleus is approximately the same as that in the chromatin itself; these nuclei are very small and dense, and the quantity of arginine which could be present in the nuclear sap would be negligible.

Erythrocyte nuclei were isolated by a technique described previously[2]. As regards sperms, the measurements were made on whole mature sperms. Cytochemical observations showed that the arginine is chiefly localized in the sperm head; if there is arginine in the intermediate part, the error would not be important. Arginine was estimated by the colorimetric technique of C. Dumazert and R. Poggi[3].

From the results reported in the accompanying table, we see that the ratio of deoxyribonucleic acid content of all the erythrocyte nuclei studied and of some of the fish sperms to the arginine content in

Individual Amounts of Arginine and Deoxyribonucleic Acid (in 10^{-6} γ) of Erythrocyte Nuclei and Fish Sperms

Species	Erythrocytes DNA	Arginine	DNA/Arginine	Sperms DNA	Arginine	DNA/Arginine
Perch	2·0	0·37	5·4			
Barbel	3·4	0·64	5·3			
Roach	1·9	0·36	5·3			
Tench	1·7	0·34	5·0	0·85	0·18	4·77
Carp	3·2	0·60	5·3	1·60	0·35	4·40
Trout	4·9	0·96	5·1	2·45	1·50	1·63
Pike	1·7	0·34	5·0	0·85	0·53	1·60
Fowl	2·2	0·45	4·9			
Calf thymus						
Bull	6·4	1·49	4·3	3·20	2·16	1·48

the same nuclei is practically constant, in spite of important variations of content of deoxyribonucleic acid. For fowl erythrocytes and calf thymus nuclei the ratio was of the same order of magnitude. In tench and carp, the amount of arginine in a single sperm is about half that in an erythrocyte nucleus. These results are consistent with the hypothesis that arginine molecules are fixed to acidic groups of deoxyribonucleic acid as bonds between the acid and the protein moiety of the nucleoprotein[4]. In trout and pike sperm, however, this correlation does not exist; we suggest, therefore, that in these species the protein moiety itself undergoes a transformation during spermatogenesis, accompanied by a marked synthesis of arginine. In tench and carp, on the contrary, the transformation of the protein residue may be accompanied by the synthesis of a different amino-acid—histidine or lysine—so that the parallel diminution of the arginine linked to deoxyribonucleic acid and of the acid itself would appear directly in the results of our analysis. Finally, the bull sperm shows a deoxyribonucleic acid/arginine ratio which is not very different from that of trout and pike; hence the still unknown nucleoprotein, which might be obtained from bull sperm, if an appropriate method of extraction was available[5], would be a nucleoprotamine rich in arginine.

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[1] Vendrely, C., *Bull. Biol. France et Belgique*, **86**, 1 (1952).
[2] Vendrely, R., and Vendrely, C., *Experientia*, **4**, 434 (1948).
[3] Dumazert, C., and Poggi, R., *Bull. Soc. Chim. Biol.*, **21**, 1381 (1939).
[4] Stern, K. G., *Exp. Cell Res., Supp.* 2, 1 (1952).
[5] Dallam, R. D., *Nature*, **170**, 377 (1952).

Variations in the Content of Deoxyribonucleic Acid in the Human Uterine and Vaginal Receptors during the Menstrual Cycle

The histophotometric method, as used by L. Lison[1], permits the estimation of the deoxyribonucleic acid content of individual nuclei, in sections or smears stained with the Feulgen method. The method postulates that the intensity of the Feulgen stain is directly proportional to the amount of deoxyribonucleic acid present. This very important point has been fully discussed by several authors[2-5], and is now generally regarded as satisfactorily proved.

Applying this optical method, we have studied the variations of the deoxyribonucleic acid content in the nuclei of the endometrial stroma and in the vaginal cells, during several œstrous cycles.

Endometrial stroma. Our measurements, made by the histophotometric method, on individual stroma nuclei, are represented graphically in Fig. 1. The graph has been constructed from numerical results obtained at different times during the œstrous cycle of the same woman and submitted to statistical analysis. Results obtained with other women, under the same conditions, gave similar

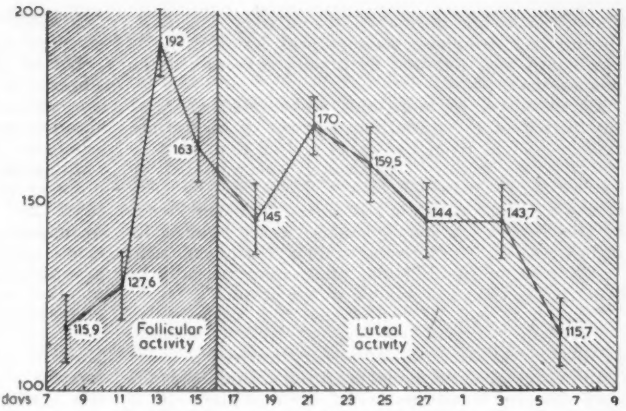

Fig. 1. Diagram of means and intervals of confidence

results. A peak in relative deoxyribonucleic acid content occurs in the proliferative phase between the eleventh and the fifteenth day of the cycle, and is followed by a progressive decrease until the end of the secretory phase. A second peak appears between the twenty-first and twenty-fourth days; it is possible that this apparent increase has no real significance from a statistical point of view, since the confidence limits between the values at the eighteenth and the twenty-first days overlap. Nevertheless, similar findings, made on vaginal smears, lead us to think that the apparent increase shown in the graph is real.

We conclude from our results that the mean deoxyribonucleic acid content of individual nuclei is not constant but varies, showing a maximum at the proliferative phase and a minimum at the end of the cycle. We can therefore not corroborate the results of Stein and Stuermer[6], obtained by purely chemical methods, who concluded that there is an increase of deoxyribonucleic acid at the late secretory phase.

Vaginal smears. The amount of nuclear deoxyribonucleic acid in vaginal cells has been measured in smears, using the same method, obtained from young mature women. Fig. 2 shows one such set of results, based on measurements made on one woman. An important increase in the mean deoxyribonucleic acid content occurs at the proliferative

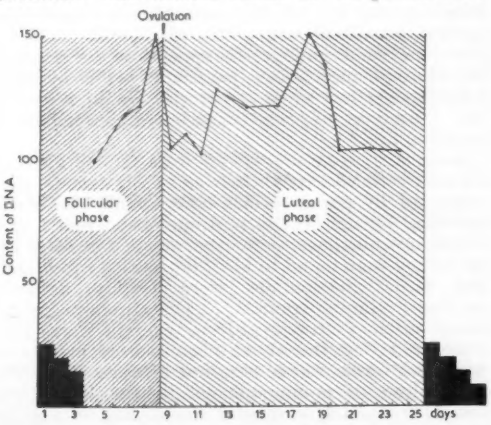

Fig. 2. Variations in the contents of deoxyribonucleic acid in the vaginal cells during a woman's menstrual cycle

phase, with an abrupt post-ovulatory decrease. During the luteal phase, a second peak is shown, at the nineteenth day, followed by a steep decrease, at the premenstrual phase.

Furthermore, we were able to establish that, at any period of the cycle, the amount of deoxyribonucleic acid in pycnotic nuclei is less than that in non-pycnotic nuclei. Pycnosis is accompanied by loss of deoxyribonucleic acid. Therefore the peak at the follicular phase is still more significant, since at this period the karyopycnotic index reaches its highest values. The increase of deoxyribonucleic acid at the peak of the follicular phase must actually be even higher than that shown in the graph.

Finally, it can be stated that the variation of deoxyribonucleic acid in vaginal cells is roughly parallel to the excretion of urinary œstrogen.

In pathological hormonal conditions, similar results were observed in stroma nuclei, sections and vaginal cells in smears : namely, increase in the mean amount of deoxyribonucleic acid accompanying high follicular stimulation (hyperplasia glandulo-cystica), low deoxyribonucleic acid content in hypofolliculinic conditions (endometrial atrophy, senility).

The results of our measurements are not in accordance with the statement of several recent authors, that the nuclear content in deoxyribonucleic acid is constant in all the nuclei of the same organism. As shown by Lison and Pasteels[2] for other tissues, it presents marked fluctuations probably related to the metabolic activity of the cell.

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[1] Lison, L., *Acta Anatomica*, **10**, 23 (1950).
[2] Pollister, A. W., and Swift, H., *Science*, **3**, 68 (1950).
[2] Lison, L., and Pasteels, J., *Arch. Biol.*, **62**, 1 (1951).
[4] Vendrely, C., *Bull. Biol., Fr. et Belg.*, **86**, 1 (1952).
[5] Leuchtenberger, C., *Chromosoma*, **3**, 449 (1950).
[6] Stein, R., and Stuermer, L., *Amer. J. Obst. Gyn.*, **61**, 414 (1951).

Formation of Glucosides from Phenols in Locusts

During investigations in this laboratory on the fate of foreign organic compounds in locusts, we wished to find out whether these insects formed conjugated glucuronic acids. In the higher animals, glucuronic acid conjugation appears to be a major detoxication mechanism particularly for hydroxy compounds[1]; but there appears to be no record in the literature of this mechanism occurring in invertebrates.

Locusts (*Locusta migratoria*) were therefore fed or injected with various phenols and their excreta were examined by paper chromatography for the corresponding β-glucuronides. *m*-Aminophenol and 7- and 8-hydroxyquinolines were used as test substances, since they were found to be of low toxicity to locusts and their glucuronides were readily detected on paper chromatograms[2,3]. On chromatographic examination of extracts of locust excreta, it was soon discovered that the above phenols were present in combined forms which were not glucuronides. The metabolism of *m*-aminophenol in the locust was therefore studied in greater detail, and it appears that the combined form of this phenol excreted by locusts is, at least in part, β-*m*-aminophenyl-D-glucoside. The evidence for this suggestion was obtained as follows.

Locust fæces collected for two days after the administration of *m*-aminophenol (1 mgm./locust) were extracted with aqueous ethanol and the extract chromatographed on paper on a large scale in *n*-butanol/acetic acid/water (4 : 1 : 5). The appropriate zone was eluted with water and re-chromatographed in *n*-butanol/benzene/ammonia (s.g. 0·88) (5 : 2 : 2). The zone containing the conjugated *m*-aminophenol was again eluted with water. The eluate gave a positive diazo test for aromatic amino groups and had an ultra-violet absorption maximum at the same wave-length as β-*m*-aminophenyl-glucuronide (that is, 266 mμ in 0·1 *N* hydrochloric acid and 282 mμ in 0·1 *N* sodium hydroxide). However, the eluate gave a negative naphthoresorcinol test for glucuronic acid, and the compound present was shown to have no acid function by paper ionophoresis in buffers at different *p*H's. The conjugate was decomposed more rapidly than β-*m*-aminophenyl-glucuronide by dilute acid, 30 min. at 100° in 0·5 *N* hydrochloric acid being sufficient for complete hydrolysis, and *m*-aminophenol was readily detected spectroscopically in the hydrolysate. After chromatography of the hydrolysate in *n*-butanol/acetic acid/water (4 : 1 : 5), only *m*-aminophenol and glucose, with traces of xylose, could be found. A small amount of needle-shaped osazone was also obtained from the hydrolysate.

These results suggested that the combined form of *m*-aminophenol in locust fæces was *m*-aminophenyl-glucoside. An authentic solution of β-*m*-aminophenyl-glucoside was therefore prepared[5] by deacetylation of the tetra-acetate (m.p. 153–54° and $[\alpha]_D^{20} - 31°$). The metabolite in locust fæces had the same R_F value as the authentic glucoside in three different solvents, namely, 0·43 in *n*-butanol/acetic acid/water (4 : 1 : 5), 0·17 in *n*-butanol/benzene/ammonia (s.g. 0·88) (5 : 2 : 2) and 0·80 in pyridine/ethyl acetate/water (1 : 2 : 2). The metabolite was also hydrolysed by emulsin, yielding, as shown by paper chromatography, *m*-aminophenol and glucose, thus suggesting for it a β-glucoside structure. This was supported by the negative optical rotation of the concentrated eluates of the metabolite. Thus, short of actual isolation of the metabolite in crystalline form, the above evidence suggests that *m*-aminophenol is partly converted in locusts not to β-*m*-aminophenyl-D-glucuronide, but to β-*m*-aminophenyl-D-glucoside.

This is the first time that a glucoside has been detected as a metabolite of a phenol in the animal kingdom. The formation of β-glycosides (β-glucosides and β-gentiobiosides) from foreign compounds, however, has been shown to occur in the plant kingdom[4], and it has been suggested that it represents a detoxication mechanism in the plant analogous to glucuronide formation in animals.

It is possible that glucoside formation in the locust may be related to the anatomy of its excretory organs, because the Malpighian tubules, unlike the vertebrate kidney, empty into the gut of the insect. The locust has been shown to possess a rich source of β-glucuronidase in its crop[3] and, if β-glucuronides were formed, they might be hydrolysed again in the gut. β-Glucuronide formation on these grounds could be ineffective as a detoxication mechanism. However, it is not known whether β-glucosidase occurs in the locust.

We are grateful to Prof. R. T. Williams for his interest in this work and to the Anti-Locust Research

Centre (British Museum (Natural History)) for grants and supplies of locusts.

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[1] Williams, R. T., "Detoxication Mechanisms" (Chapman and Hall, 1947).
[2] Williams, R. T., *Biochem. J.*, **37**, 329 (1943); Smith, J. N. (unpublished data).
[3] Robinson, D., Smith, J. N., and Williams, R. T., *Biochem. J.*, **53**, 125 (1953).
[4] Hill, R., Ann. Rep. Chem. Soc., **37**, 434 (1940). Pigman, W. W., and Goepp, R. M., "Chemistry of the Carbohydrates", 509 (Academic Press, Inc., New York, 1948).
[5] Latham, H. G., May, E. L., and Mosettig, E., *J. Org. Chem.*, **15**, 881 (1950).

Changes in the Vascular and Lipoid Pattern of the Adrenal Cortex of the Rat following Hypophysectomy

As a preliminary to an investigation of the effect of adrenocorticotropic hormone upon the circulation through the adrenal of the rat, it was necessary to study the normal adrenal vascular pattern and, in addition, that of the hypophysectomized rat, at weekly intervals after operation (1–16 weeks). The rats were injected intravitally with a mixture of equal parts of indian ink and distilled water pumped direct into the left ventricle at a constant injection pressure of 160 mm. mercury. The adrenals were fixed in 10 per cent formol saline after ligation of the vascular pedicle, and sections were cut at 50 μ after gelatine or celloidin embedding. Satisfactory preparations were obtained for a study of both the vascular pattern and the lipid distribution.

In normal rats the capillary pattern in the adrenal cortex as demonstrated by intravital indian ink injections shows three concentric zones. (1) An outer injected zone comprising the capillaries of the zona glomerulosa; (2) an intermediate 'zona lucida'[1] of poorly filled capillaries corresponding to the lipid-free cells of the 'zona intermedia'[2] ('transitional zone'[3], 'sudanophobic zone'[4], 'zone of compression'[5]), plus a small but variable depth of the outer part of the zona fasciculata; (3) an inner heavily injected zone of capillaries in the rest of the zona fasciculata and the whole of the zona reticularis. Careful measurements show that the outer edge of the zona lucida corresponds to the inner edge of the zona glomerulosa.

In hypophysectomized rats, owing to cellular shrinkage, which is most marked in the zonæ fasciculata and reticularis, there is a reduction in the inter-capillary distance with a resulting increase in the number of capillaries per unit area. These capillaries are also narrower than in the normal rat. For the first three weeks after operation a normal type of vascular zoning persists; thus with an increase in the depth of the zona intermedia there is a corresponding increase in the depth of the zona lucida (in ink preparations), and the sudanophobe zone (in lipoid preparations). An increase in depth of the zona glomerulosa is a recognized sequel after hypophysectomy[6], but it was found that this increase was maximal at about the fifth week, after which a decrease was observed[1]. Between the fifth and eighth week there is a general reduction in the number and size of the capillaries throughout the cortex, which becomes much less vascular. By this time the zonæ fasciculata and reticularis are very narrow, and there is a tendency towards homogeneity of cell-size throughout the cortex.

The lipid changes in the adrenal cortex of the rat during the first three weeks following hypophysectomy are well known. The striking change is the gradual widening of the fat-free zona intermedia or sudanophobe zone. We have noticed three additional points. (1) The outer half of the zona glomerulosa sometimes becomes free from lipid while the inner half is still heavily laden. To date we have not been able to correlate this change with any specific treatment such as castration or injection of adrenocorticotropic hormone. We have observed differences in the capillary pattern of the inner and outer layers of the zona glomerulosa. It is possible that the zona glomerulosa might consist of two layers with different functions. (2) In rats hypophysectomized 16 weeks previously, the lipid-containing zonæ fasciculata and reticularis are very narrow or completely absent. Either these zones have disappeared or their cells have become completely depleted of lipid. The cortex of these rats is even more poorly vascularized than at 8 weeks. (3) From 5 weeks onwards after hypophysectomy, a few cords or lipid-containing cells from the zona glomerulosa are sometimes found invading the sudanophobe zone.

Conclusion. The poor filling of the capillaries in the zona intermedia of normal adrenals and in adrenals from recently hypophysectomized rats is a surprising finding. Large cells distended with lipid would be expected to press upon capillaries, but the capillary constriction is present at the site of small cells without lipid content. The cells of the zona intermedia still appear smaller than the cells of the adjacent zones in sections of freeze-dried vacuum-embedded adrenals. It is therefore unlikely that the cells of this zone have been artificially reduced in relative size by the ordinary methods of fixation. The Gomori method for alkaline phosphatase on these freeze-dried adrenals gives an excellent picture of the vessel walls and confirms the vascular pattern shown by intravital injection of indian ink.

The true function of the cells of the zona intermedia remains unsolved. There is no evidence for the widely held view that this is the zone of active mitosis in the adrenal cortex[5,7]. If there is a vascular stop-cock mechanism present in this zone, it would not appear to depend upon the mechanical properties of the cells. There remains the possibility of local capillary constriction. Lever has recently described nerve endings in the zona glomerulosa[8].

A more detailed report on the vascular and morphological findings has been prepared by one of us[1]. We are grateful to the Nuffield Foundation for generous support of this work.

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[1] Lever, J. D. (in the press).
[2] Nicander, L., *Acta Anat.*, **14**, supp. (1952).
[3] Greep, R. O., and Deane, H. W., *Endocrinol.*, **40**, 417 (1947).
[4] Simpson, M. E., Evans, H. M., and Li, C. H., *Endocrinol.*, **33**, 261 (1943).
[5] Mitchell, R. M., *Anat. Rec.*, **101**, 161 (1948).
[6] Deane, H. W., and Greep, R. O., *Amer. J. Anat.*, **79**, 117 (1946).
[7] Cater, D. B., and Stack-Dunne, M. P., *J. Path. Bact.* (in the press).
[8] Lever, J. D., *Nature* [**171**, 882 (1953)].

Effect of Molybdenum Deficiency on Nitrate Reductase in Cell-free Extracts of *Neurospora* and *Aspergillus*

Although numerous investigators have shown that molybdenum is important for the utilization of nitrate nitrogen by fungi and higher plants[1,2], the role of the micronutrient element in the enzyme systems involved has not been determined. We have recently been able to show that the concentrations of nitrate reductase in cell-free extracts of molybdenum-deficient *Neurospora* and *Aspergillus* are markedly decreased to the extent of one-fifth to one-thirtieth of that of normal tissue. However, the nitrite activity, designated as nitrite reductase[3], of these extracts was significantly increased in *Neurospora* (5297*a*) and *Aspergillus* compared to that of the controls.

Neurospora crassa wild types 146 (microconidial type) and 5297*a* (macroconidial type) were grown on a modified Fries medium containing nitrate as the sole source of nitrogen, and on another in which ammonium nitrate and ammonium tartrate were supplied[3]. *Aspergillus niger* (*M* strain) was grown on a nitrate medium[4]. The removal of molybdenum was achieved by the copper and lead coprecipitation methods as previously described[3,4]; molybdenum was then added back to some of the media which served as the controls. Cell-free extracts and dry-weight measurements were obtained by a method described elsewhere[5]. Protein content of the enzyme extracts was determined by the biuret procedure[5]. The activities of the nitrate and nitrite reductases were measured by the appearance and disappearance, respectively, of nitrite and are expressed in the same units as defined earlier[3]. At least 80 per cent of these enzymes were present in the cell-free extracts as compared to the whole homogenates.

The accompanying table shows that the specific activity of nitrate reductase in cell-free extracts of molybdenum-deficient *Neurospora* is reduced to 10–50 per cent of that of the controls whether grown on a medium containing only nitrate or both nitrate and ammonia as the source of nitrogen. *Aspergillus* showed the same general response (see table) as *Neurospora*; the molybdenum deficiency obtained with *Aspergillus* was more severe as indicated by growth, and accordingly the decrease in nitrate reductase was greater, resulting in values 4–6 per cent of that of the controls. On the other hand, the specific activity of nitrite reductase in *Neurospora* (5297*a*) and *Aspergillus* was considerably increased in cell-free extracts of molybdenum-deficient tissues; in some instances a 15-fold increase was recorded. Preliminary experiments have indicated that the nitrate reductase in *Aspergillus* has the same requirements in terms of its specificity for reduced triphosphopyridine nucleotide and its activation by flavin adenine dinucleotide or flavin mononucleotide as in *Neurospora*. The nitrite reductase appears to be similar to that found in *Neurospora*.

The addition of molybdenum (10^{-3} microgram per 0·5 ml. reaction mixture) to the molybdenum-deficient extracts failed to increase nitrate reductase activity. The mixing of extracts of molybdenum-deficient and normal mycelia of *Neurospora* demonstrated the absence of an inhibitor or activator in the tissues in regard to both nitrate and nitrite reductase activities.

It has already been shown that individual deficiencies of iron, zinc and manganese in *Neurospora crassa* (5297*a*) resulted in a marked increase in nitrate reductase, while a nitrogen deficiency caused a striking decrease[3]. We have recently produced a copper deficiency in *Neurospora* (5297*a* and 146) by a double sulphide precipitation technique at *p*H 3·7 [2,4], which resulted in a four-fold increase in specific activity of nitrate reductase as compared with normal tissues. Thus only a nitrogen deficiency (which presumably affects protein metabolism) and molybdenum deficiency lower the nitrate reductase. Whether molybdenum is a component of the nitrate reductase system or whether it exerts its effect indirectly by influencing protein metabolism is not known. Experiments now in progress may elucidate this point.

Effect of Molybdenum Deficiency on Nitrate Reductase of *Neurospora* and *Aspergillus* Extracts
Units of nitrate reductase expressed as $\mu M \times 10^3$ of nitrate formed per mgm. protein

Fungus	Nitrogen source	Treatment	Per cent growth	Nitrate* reductase
Neurospora crassa No. 146	Nitrate only	+ Mo	100	20·5
		− Mo	29	4·8
5297*a*	Nitrate only	+ Mo	100	10·7
		− Mo	32	1·2
146	Nitrate and ammonia	+ Mo	100	48
		− Mo	50	20
5297*a*	Nitrate and ammonia	+ Mo	100	14·2
		− Mo	55	2·2
Aspergillus niger *M* strain	Nitrate only	+ Mo	100	45·3
		− Mo	5	1·6
M strain†	Nitrate only	+ Mo	100	38·8
		− Mo	31	2·4

* Reaction mixture contained the following: 0·1 ml. 0·1 *M* potassium nitrate, 0·02 ml. 10^{-2} *M* potassium cyanide, 0·04 ml. flavin mononucleotide (500 μgm./ml.), 0·04 ml. reduced triphosphopyridine nucleotide (2 μM/ml.). The reaction mixtures were made up to 0·5 ml. with 0·1 *M* pyrophosphate buffer, *p*H 7·0.

'+ Mo' cultures contain 2 μgm. Mo per 125 ml. (*Neurospora*) and 2 μgm. Mo per 50 ml. (*Aspergillus*).

† In this experiment, 10^{-3} μgm. Mo only was supplied to the "− Mo" flasks.

Note added in proof. Since this communication was submitted we have demonstrated that both the molybdenum content and specific activity of nitrate reductase increase with purification of the enzyme. Moreover, inactivation of the enzyme by dialysis against cyanide is accompanied by a decrease in molybdenum content of nitrate reductase. The inactivated enzyme is almost fully restored by the addition of molybdenum trioxide or sodium molybdate as compared to the other micronutrients.

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[1] Virtanen, A. I., and Rautenen, N., "The Enzymes, Chemistry and Mechanism of Action", **2**, Pt. 2 (Acad. Press, N.Y., 1952).
[2] Nicholas, D. J. D., and Fielding, A. H., *J. Hort. Sci.*, **26**, No. 2, 125 (1951).
[3] Nason, A., and Evans, H. J., *J. Biol. Chem.*, [**202**, 655 (1953)].
[4] Nicholas, D. J. D., *J. Sci. Food and Agric.*, **1**, 339, 44 (1950).
[5] Nason, A., Kaplan, N. O., and Colowick, S. P., *J. Biol. Chem.*, **188**, 397 (1951).

The Röntgen: Deficiencies in Present-day Free-Air Chamber Standards

THE röntgen is defined as "that quantity of X- or gamma-radiation such that the associated corpuscular emission per 0·001293 gm. of air produces, in air, ions carrying 1 e.s.u. of charge of either sign". An ionization chamber designed for the realization of this unit must therefore provide sufficient space around the air volume in which the primary ionization occurs to permit the corpuscles from it full range, effectively. In the parallel-plate type of chamber, this involves not only sufficient electrode spacing, but also adequate dimensions at right angles, that is, lateral to the X-ray beam. It was recognized in the design of the typical standards set up more than twenty years ago in Great Britain[1] and the United States[2] that the actual electrode spacing need not be so great as might at first sight be thought necessary on theoretical grounds. Thus for 200-kV. X-rays, a plate spacing approaching 70 cm. (with effectively equal lateral dimensions) is theoretically desirable, whereas, in fact, the ionization losses with dimensions considerably less than these may be negligible. Thus 10 cm. only was adopted as the plate-spacing in the chamber set up at the National Physical Laboratory, Teddington, and 12 cm. in that at the U.S. Bureau of Standards.

We have shown in our experiments that, assuming the chamber geometry to be adequate in other respects, these values of plate-spacing would lead to ionization losses of about 0·5 and 0·1 per cent respectively with 200-kV. medium-filtered radiation. However, critical consideration of the lateral geometry in these two chambers (including electrolytic tank studies to elicit the electrostatic field conditions) reveals the existence of relatively serious deficiencies. Thus the effective lateral dimension of the collecting region in the National Physical Laboratory chamber was found to be a little less than 7 cm., largely as a result of the incorporation of unnecessary and, indeed, undesirable lateral guard plates. The corresponding dimension in the U.S. National Bureau of Standards chamber was estimated to be 8 cm. The resulting lateral losses in both chambers are hence far more serious, and we have concluded that they exceed 2 per cent in the National Physical Laboratory chamber and are almost 1·5 per cent in the National Bureau of Standards chamber at 200-kV.

These deductions were made from a series of experiments, employing a free-air chamber pair in conjunction with a Kemp-type precision X-ray comparator[3], one of the chambers being housed in a pressure-casing so that the effective dimensions of the electrode assembly could be varied by alteration of the air pressure within the chamber. As a check on our conclusions in the case of the National Physical Laboratory chamber, we built an exact geometrical replica of the latter and made a direct comparison of it with our own over a range of X-ray qualities (again using the X-ray comparator). The losses predicted by the pressure-change experiments and those observed by direct comparison are set out in the accompanying table.

kV.	Filter	Losses of N.P.L. chamber due to inadequate geometry	
		From pressure-change experiments	By direct comparison
60	Nil	Nil	Nil
75	1 mm. Al	Nil	Nil
100	1 mm. Al	0·4 per cent	0·4 per cent
145	0·2 mm. Cu + 1 mm. Al	1·9 ,,	2·3 ,,
190	0·47 mm. Cu + 1 mm. Al	2·5 ,,	2·9 ,,

Thus the existence of the losses was confirmed by the direct comparison, which indicated that if anything the losses had been under-estimated in the original series of experiments.

This investigation is being described in a paper before the International Congress of Radiology at Copenhagen during July; an account of the experiments themselves will be published elsewhere in due course.

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[1] Kaye, G. W. C., and Binks, W., *Brit. J. Rad.*, **6**, 530 (1933).
[2] Taylor, L. S., and Singer, G., *Radiology*, **15**, 637 (1930).
[3] Kemp, L. A. W., *Brit. J. Rad.*, **18**, 107 (1945); **19**, 233, 301 and 488 (1946); **24**, 211 (1951).

Alternating-Current Energy Losses in Iron Laminations at Magnetic Saturation

A LIMIT to the power output of most rotating electrical machines is set by magnetic saturation in the teeth of the punchings employed. Designers of these machines have, however, never had data available on the specific iron losses of the materials they use for alternating flux densities higher than about 75 per cent of the saturation value. The usual methods of measurement, applied to specimens of the material, fail completely at higher flux densities than this because the power factor becomes very small and the magnetizing current very high. The former introduces difficulties when wattmeters are used, and the latter when thermal methods are contemplated. We have successfully used the following method.

A small four-limbed core of laminations was built up, the specimen under test being a single strip near the centre of one limb. This limb was wound with a magnetizing coil and was of smaller cross-section than the other three. Strips, of the same width as the test piece, of a non-ferromagnetic resistance material were placed above and below the test piece and separated from it by small air spaces. A pair of thermocouple junctions in opposition were placed, one on the test piece and the other on the adjacent surface of a resistance guard strip. This thermocouple circuit was connected to a very sensitive and stable photoelectric galvanometer amplifier which was used only as a null detector. In carrying out a test, the specimen was magnetized from a 50 c./s. supply. At the same time the guard strips were heated by passing a current through them, this being adjusted by trial to give the same rate of rise of temperature. Thus, for a given flux density $B_{max.}$ in the specimen and correct adjustment of the current in the guard strip, simultaneous closing of both circuits would produce no deflexion of the galvanometer. Then, from the specific heats of the two materials and the electrical resistivity of the guard strip, the iron loss in the specimen could be determined. Alternatively, and as a check, a method of direct calibration was also used in which the specimen was first heated by the iron losses and then, secondly, heated by passing a current through it also.

The method has worked well and has a number of advantages. The magnetizing current need not be applied for a period greater than about four seconds for each reading. There is therefore no difficulty due

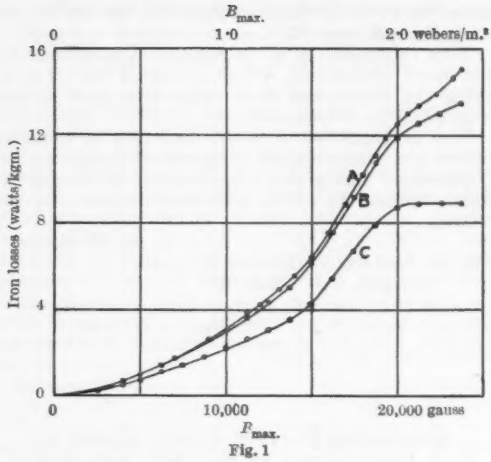

Fig. 1

to heating up of the magnetizing coil, which can be heavily over-run in order to reach high flux-densities. Since the basis of the method is that specimen and guard strips shall have the same rate of rise of temperature, there is no difference in temperature between them and so no errors due to flow of heat from one to the other.

It is advisable that any results presented should correspond to a sinusoidal flux density. It seems to be almost an experimental impossibility to maintain a sinusoidal flux wave-form at these very high flux densities with equipment of reasonable size, although Cormack[1] has described an elaborate system which he used up to fairly high flux densities. In the present work, no great precautions were taken to secure a good wave-form; but form-factors of the induced e.m.f. waves were determined and a correction applied for the resulting increased calculable eddy-current component of the total iron loss.

Tests have been made on several materials. The results for a sample of ordinary dynamo iron, containing about 0·5 per cent silicon, are of most practical interest. These are shown in the graphs. The highest flux density reached was $B_{max.} = 23{,}750$ gauss (2·375 webers/m.²) with an applied field $H_{max.} = 2{,}500$ oersted. The curves shown are: (*A*), observed total iron loss; (*B*), total iron loss corrected to sinusoidal flux density; (*C*), hysteresis component of total loss, obtained by subtracting the calculated eddy-current component. The curves indicate that the hysteresis component reaches a saturation value. If this is indeed the case, the iron losses at flux densities still greater than the highest figure mentioned above, should these be required, are obtainable by adding a calculable eddy-current component to the saturation hysteresis loss.

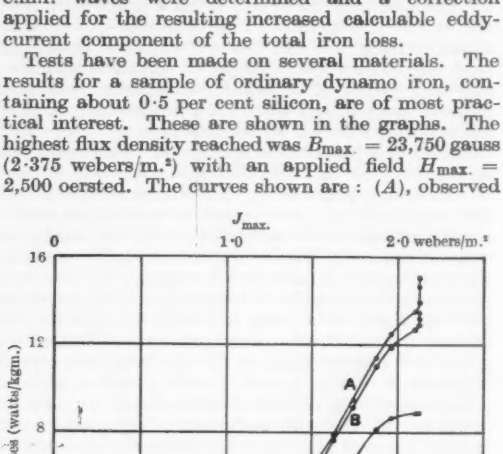

Fig. 2

We wish to acknowledge assistance from the Electrical Research Association in the purchase of some of the equipment used, and also that one of us (C. G. B.) is receiving a maintenance grant from the Department of Scientific and Industrial Research.

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[1] Cormack. *Trans. S. Afr. Inst. Elect. Eng.*, **38**, 257 (1947).

A Presumed Ascomycete from the Upper Carboniferous

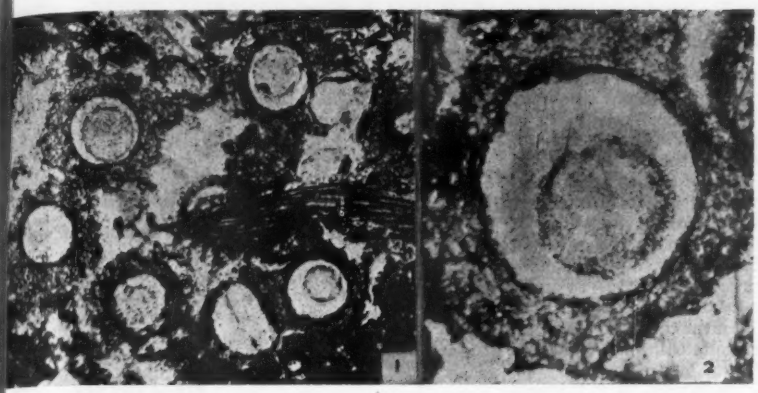
This fungus was found during a recent examination of a single section cut from a coal ball collected at the Moorside Colliery, near Halifax, Yorkshire. The section has been in the departmental teaching collection at Glasgow for many years; but it has rarely been examined as it does not contain interesting specimens of other plants.

The material consists of sections of seventeen spherical fructifications 275–400 μ in diameter with single central cavities 125–250 μ in diameter. The wall structure is similar to that of an ascocarp, being made up of four to eight layers of thick-walled closely packed hyphæ 5–20 μ in diameter. In most places the hyphæ are cut in transverse section and they are too closely interwoven to permit detailed study of their structure; but in the few areas where they run obliquely they can be seen to be septate and branched. There is no sign of an ostiole. The fructifications lie freely, in some cases in contact with each other.

A ring of dark material can be made out in a number of the cavities. The details of the structure of this ring cannot be distinguished; but in its position and dimensions it closely resembles the layer of ascogenous cells around the cavity of the young perithecium of some of the Sphæriales. Such traces of cellular arrangement as can be made out do not conflict with this similarity.

After completing the examination of the above material, similar fructifications were discovered in sections of a coal ball taken from the Bouxharmont seam at the Werister Colliery, Liège. Prof. Suzanne Leclercq courteously made the coal ball available for this laboratory, and a series of sections are now being prepared from it. The sections so far examined have confirmed the rounded shape of the fructifications, the nature of the cell walls and the absence of an ostiole. In some cases a small number of irregularly arranged rounded bodies have been seen in the cavities. They are 30–50 μ in diameter and have a slightly thickened wall.

Definite evidence of asci or ascospores has not been found in any section, but great resemblance to living ascomycetes is shown by the shape, the structure of the wall and the general appearance of the contents of the cavity. There have been many



(1) Group of fructifications from Moorside Colliery. (2) Single fructification, showing ring of dark material in the perithecium cavity

reports of casts and impressions of perithecium-like structures from Tertiary rocks, but there are no previous records of a section of a fungus of this type from the Palæozoic.

It is thought that the fructifications are of a new species of ascomycete, and a detailed account and diagnosis will be published elsewhere.

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Secondary Growth in Petioles and the Partial-Shoot Theory of the Leaf

Isolated leaves are able to live independently in soil with root systems of their own induced from their petioles by the application of synthetic hormones[1]. Leaves of *Amaranthus gangeticus*, Linn. var. *tristis* were grown in soil with such root systems induced by an aqueous solution of β-indolyl butyric acid of the strength of five parts per million. After a month the petioles became thicker and stouter, and transverse sections, a photomicrograph of one of which is given in Fig. 1, revealed an anomalous type of secondary growth peculiar to the stem of the species.

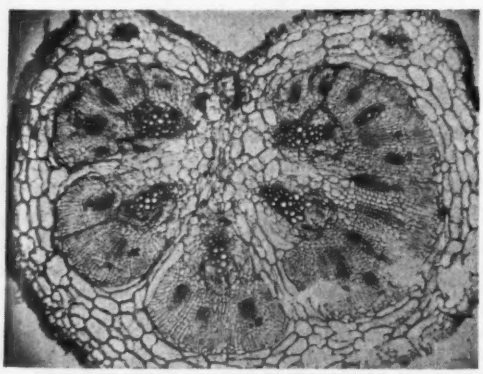

Fig. 1. Transverse section of the petiole of a rooted leaf of *Amaranthus gangeticus*, Linn. var. *tristis*, showing an advanced stage of secondary growth

Fig. 2 depicts a transverse section of a petiole of a leaf of the same age attached to the plant and shows no secondary growth. Secondary growth is initiated outside the original vascular bundles by accessory cambium formed in distinct arcs. Small discrete groups of secondary xylem are cut off inwards and are embedded in parenchymatous conjunctive tissue whereas phloem is poorly developed. No interfascicular cambium is formed and secondary growth takes place within the primary bundles by the activation of the rudimentary fascicular cambium.

Secondary growth is also seen in the petioles of rooted leaves of *Chenopodium album*, Linn. and *Ipomœa batatas*, Lamk., and the types are the same as seen in their respective stems. It is known that auxin controls cambial growth[2]. In these cases it seems that the formation of accessory cambium and the activation of fascicular cambium are due to the synthetic hormone, which is also responsible for the root formation.

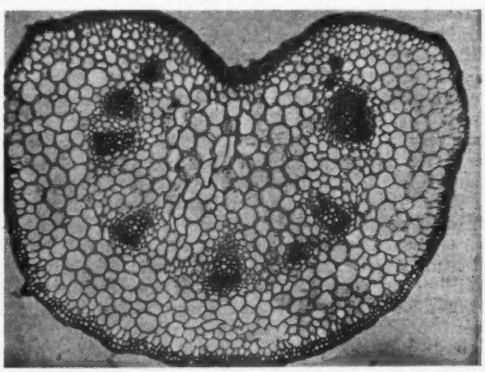

Fig. 2. Transverse section of the petiole of a rooted leaf of *Amaranthus gangeticus*, Linn. var. *tristis* of same age as that of the rooted leaf, but attached to the plant

The phenomenon of the production of secondary growth in petioles has a very important bearing in determining the morphological nature of the leaves. It is seen that the type of secondary growth in the petiole is the same as in the stem of a particular species and, in our opinion, this fact is one of the strongest pieces of evidence in support of the partial shoot theory of the leaf as elaborated by Arber[3].

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T. Kabi

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[1] Gregory, F. G., and Samantaral, B., *J. Exp. Bot.*, **1**, 159 (1950).
[2] Snow, R., *New Phyt.*, **34**, 349 (1935).
[3] Arber, A., "The Natural Philosophy of Plant Form", 70 (1950).

Protective Effect of Aged Vaccines on a Neurotropic Virus Infection in Mice

A number of clinical observations have established that recent immunization with diphtheria or whooping cough vaccines renders children more susceptible to poliomyelitis infection (see Hill and Knowelden[1] for references). A similar effect has been demonstrated in mice infected with the virus of mouse encephalomyelitis (*GD*VII strain) in experiments which are being reported fully elsewhere. During the course of the work, however, it was observed that the injection of vaccines which had been stored for several months no longer made the mice more susceptible to virus infection, but instead exerted a protective effect. It is felt that these findings, if confirmed, might have an important bearing on both clinical and biological problems.

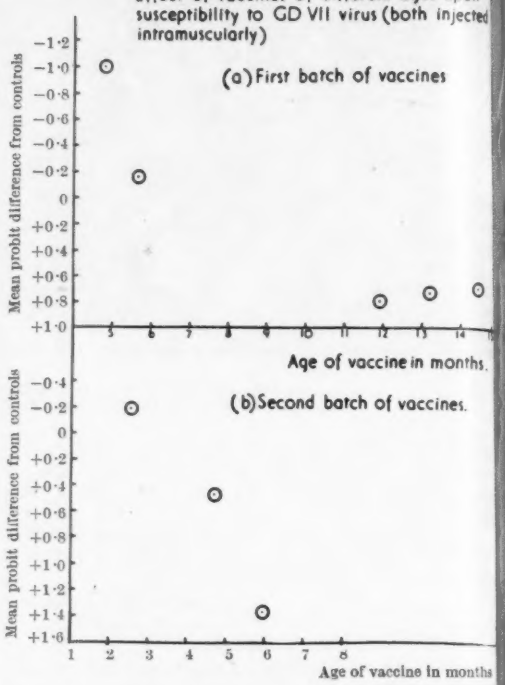
The vaccines used were Diphtheria *A.P.T.*, prepared by Burroughs Wellcome, and a pertussis vaccine prepared by the Medical Research Council. Both were stored at 0–3° C. throughout the experiment. Serial tenfold dilutions of a standard suspension of virus-infected mouse brain (containing 3×10^9 intracerebral *LD* 50's per ml.) were injected into batches of three- to four-week old mice, 0·03 ml. into the calf muscle of each mouse; and from the numbers in each batch which succumbed, the 50 per cent lethal dilution was estimated by probit methods[2]. In the experimental series, a standard dose containing one part of each vaccine and four parts of distilled water was injected into the same leg muscles, usually 48 hr. after the injection of virus, and the 50 per cent lethal dilution again calculated. The altered susceptibility of the vaccine-treated series could then be expressed in terms of the 'mean probit difference'[2] between the experimental and the control series.

The first supply of vaccines was obtained and tested in February 1951. The diphtheria vaccine had been prepared in October 1950, and was marked as fit for use until October 1952; the date of manufacture of the pertussis vaccine was not known.

When first tested, the combined vaccines increased approximately tenfold the susceptibility of mice to virus given 48 hr. previously. A month later, however, treatment with the same batch of vaccines produced little or no apparent increase in susceptibility. In September, the same vaccines were tested again, and were now found to decrease nearly tenfold the susceptibility of the mice to virus. This protective effect of the vaccine treatment was confirmed in a further experiment in November, and again in December. The probability of the apparent protective effect observed in these three experiments arising as a result of chance variation alone is less than one in a thousand.

A fresh supply of vaccines was obtained in December 1951. The pertussis vaccine was from the same batch as before, while the Diphtheria *A.P.T.* was from a new lot, prepared in October 1951. The fresh vaccines again increased susceptibility when first tested (though to a lesser extent than the first batch), but by February showed a slight protective effect, and when last tested, in March 1952, increased the resistance of the mice more than tenfold, with again a very high degree of statistical significance ($P < 0{\cdot}001$).

In the accompanying figure are plotted the mean probit differences between the control mice and the groups receiving injections of the combined vaccines



48 hr. after the injection of virus. The initial increase in susceptibility, replaced in the course of a few months by an increase in resistance, is apparent for both batches of vaccine. Since the effect does not appear to be related to the season of the year, one may conclude that the properties of one or both vaccines were altering with age.

No explanation of the protective effect of the aged vaccines is offered at this stage.

The expenses of this research were met by a grant from the Nuffield Foundation for virus work in this Department. My thanks are also due to the Medical Research Council for financial support, and to Dr. F. K. Sanders for advice and help.

Anne McLaren

Department of Zoology and Comparative Anatomy, Oxford. Jan. 12.

[1] Hill, A. B., and Knowelden, J., *Brit. Med. J.*, ii, 1 (1950).
[2] Finney, D. J., "Probit Analysis" (Cambridge, 1947).

Agglutination of Red Cells by *Cl. welchii*

The hæmagglutination of sheep red cells by *Cl. septicum* and the inhibition of the reaction by specific serum has already been described[1].

Strains of *Cl. welchii* types *A*, *B*, *C* and *D*, respectively[2], grown on 5 per cent sheep blood agar for 48 hr., were suspended in normal saline solution and were treated with formalin to inactivate the hæmolysin. When two-fold dilutions were added to washed sheep red cells, incubated at 37° for an hour, and then left overnight at room temperature, a sharp end-point in the agglutination of the red cells was obtained. *Cl. welchii* types *B* and *D* were more active than types *A* and *C* (see table). Washed cultures

Effect of Formalized Cultures of *Cl. welchii* on Fresh Sheep Red Cells

Type of *Cl. welchii*	Dilutions of cultures					
	1/16	1/32	1/64	1/128	1/256	1/612
A	+	−	−	−	−	−
B	+	+	+	+	+	−
C	+	−	−	−	−	−
D	+	+	+	+	−	−

+, Agglutination of red cells; −, no agglutination.

from agar showed a higher titre of agglutinins than those from fluid medium: supernatant fluids from broth cultures were almost inert.

As was the case with *Cl. septicum*, the reaction was inhibited by the appropriate immune sera. In order to avoid confusing non-specific agglutination of red cells by these sera, a sheep red cell + horse or rabbit immune serum system was used and gave clear-cut results. Serial two-fold dilutions of antisera were incubated with red cells for half an hour and were then completed with two hæmolytic doses of bacterial culture. Both antibacterial and antitoxic sera inhibited agglutination, but the latter were the more effective. It was possible to distinguish type *A* from types *B*, *C* and *D* in this way, but the overlap between *B*, *C* and *D* prevented any sharp differentiation of these groups.

Treatment of antitoxic and antibacterial sera with heavy suspensions of the corresponding organisms failed to remove group antibodies. The end-points in hæmagglutination were also unaffected when the antisera were added to red cells, previously treated with the homologous strain, in an attempt to remove anti-agglutinins.

These experiments, which confirmed in part those reported by Gürtürk[3], show that the agglutinating factor in *Cl. welchii* cultures is associated with the bacterial cell but not with the toxin. As this factor is neutralized not only by the homologous antibody but also, except in the case of type *A*, by other antisera, the test can be used in identifying *Cl. welchii*, but not for typing the different strains.

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Feb. 16.

[1] Dafaalla, E. N., and Soltys, M. A., *Brit. J. Exp. Path.*, **32**, 510 (1951).
[2] Wilsdon, A. J., Second Rep. Inst. Anim. Path. Camb., 53 (1931).
[3] Gürtürk, S., *Z. Hyg.*, **133**, 573 (1952).

Control of a Seed-borne Disease by *Chætomium cochlioides* Pall., under Natural Conditions

Many workers have reported striking antagonism between plant pathogens and saprophytes. Most of this work has been done in pure culture or in soil partially or completely sterilized before introduction of the test organisms. There are comparatively few records of disease control under natural conditions by the introduction of an antagonistic organism.

The work briefly reported below, based on earlier investigations in the Division of Plant Pathology, University of Minnesota, is an example of such control. It was then shown that when certain Brazilian isolates of *Chætomium cochlioides* Pall. were introduced into unsterile soil, the severe blight caused by *Helminthosporium victoriæ* M. and M. on oat seedlings was prevented. Similar results have now been obtained with a more active strain of *C. cochlioides* using oat seed heavily infested naturally with *Fusarium nivale* (Fr.) Ces.

Of several media used to increase inocula of the antagonist, oat-straw saturated with a 2 per cent glucose solution was most satisfactory. This was loosely packed into litre jars, sterilized and incubated for three to four weeks at 20° C. after inoculation. The straw became permeated with the fungus and covered with perithecia and was easily incorporated into soil in this condition.

A medium loam taken from plots under continuous cultivation was used with no treatment other than those given below. Oat seed heavily infested by *F. nivale* was obtained from the Norwegian Government Seed Testing Laboratory, Vollebekk, Norway. 4-inch pots were two-thirds filled with soil, and 20 gm. of the oat straw inoculum was spread over the surface on which were placed thirty seeds. These were finally covered with about 3 cm. of soil. The pots were kept in a cool frame at a temperature of 13–16° C.

In the following experiment, typical of a number, the treatments were: (1), (2) and (3) oat-straw cultures of three strains of *C. cochlioides*; (4) seed treated with an organo-mercurial fungicide; (5) uninoculated oat-straw. Six replicates were used, and the results obtained after five weeks are shown in the accompanying table.

Control of Seedling Blight of Oats

	Treatment	Strain	Mean percentage emergence	Condition of the plants at 2/3 leaf stage		
				% Dead	% Blighted	% Healthy
1	Oat-straw culture	*A*	87·2	0	0	87·2
2	" " "	*B*	81·7	8·9	20·6	52·2
3	" " "	*C*	31·2	20·6	10·6	0
4	Organo-mercurial fungicide	—	88·3	0	3·9	84·4
5	Uninoculated oat-straw	—	26·1	17·8	8·3	0

The results show quite clearly the excellent control of disease obtained by strain *A* of the antagonist. This was as good as, if not slightly better than, that obtained by the proprietary seed-dressing. The importance of using suitable strains is demonstrated by the failure of strain *C* to produce any control and the intermediate results obtained with strain *B*. Results comparable to the above have been obtained with strain *A* using a variety of inoculation methods.

The mechanism of the control which is obtained has not yet been determined, although a certain amount of evidence has been accumulated which suggests that it is by the production and subsequent diffusion into the outer layers of the infested seed of one or more antibiotic substances. It is interesting to note, however, that the fungus is not strikingly antagonistic to *F. nivale* or other pathogens in pure culture. This aspect of the problem is being investigated, as is also the use of strain *A* in the control of other seed-borne and soil-borne pathogens, and together with the above will be reported in greater detail at a later date.

I wish to thank Dr. R. K. S. Wood for valuable help and criticism throughout these investigations.

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Eperythrozoon parvum, a Filterable Blood Parasite of Swine

Information relative to the filterability of species of the genus *Eperythrozoon* apparently has not been published previously[1]. These blood parasites are classified[1] in the order Rickettsiales, a group which includes numerous filterable agents. It is apparent that passage or retention of *Eperythrozoon* by the usual bacteriological filters would not serve as any criterion for altering their present classification.

Foote *et al.*[2] reported that the parasites of swine, *Eperythrozoon suis* Splitter and *Eperythrozoon parvum* Splitter, were both filterable through 12-lb. Mandler and possibly finer filters. This observation was made in connexion with studies on a condition of swine termed by these workers "virus anemia". However, the infectious nature of eperythrozoa was not recognized and these parasites were referred to as "artefacts" or "reactionary bodies".

A study was made of the filterability of *E. suis* and *E. parvum* in swine blood serum. Details of the filtration procedures are given in a report of this work[3]. At negative pressures not exceeding 100 mm. of mercury, *E. parvum* was found capable of traversing the 8-, 12- and 14-lb. Mandler candles. Passage was also effected through the medium (*N*) and fine (*W*) Berkefeld candles, and the Seitz *EK*. The parasite was also recovered on double filtration through two 8-lb. Mandler candles in one instance, and two 12-lb. Mandlers in another. Complete retention was obtained on double filtration with the Seitz *EK*. These filters completely retained *Serratia marcescens* in saline (300 million bacteria per c.c.) adjusted to the approximate *p*H of swine serum (*p*H 7·4).

In one instance *E. suis* passed the *N*-Berkefeld but was retained by the Seitz *EK*. In another experiment, passage was effected through the 8-lb. Mandler, but not the 14-lb. Mandler, the *W*-Berkefeld or the Seitz *EK*. In an additional trial, the parasite traversed the 8- and 14-lb. Mandlers, but was retained by the *W*-Berkefeld and the Seitz *EK*. *E. suis* was not recovered in nine other filtration experiments from serum or serum filtrates of known carriers or acute experimental cases.

E. parvum was repeatedly separated from *E. suis* and established in a pure, uncomplicated infection by filtering the serum portion of blood known to contain both species. In several experiments involving microscopically negative carriers, eperythrozoa were recovered from the cellular portion of blood only; the unfiltered serum was not infectious. This is regarded as additional evidence of the infectious nature of the *Eperythrozoon* structure, since these blood forms possess a distinct affinity for the erythrocyte.

As a result of these studies, additional information has been compiled relative to the differentiation of *E. suis* from *E. parvum*. This is summarized in the accompanying table.

Differentiation of *Eperythrozoon suis* and *Eperythrozoon parvum*

	E. suis	*E. parvum*
Morphology	Large rings (0·8–1·0 μ) with much chromatin. Discoid forms and very large irregular rings (2–3 μ) may be present	Small rings (0·5–0·8 μ) with numerous coccus forms of considerably smaller size. Often found in large numbers on single erythrocytes when organisms are rare in blood
Pathogenicity	Consistently pathogenic in heavy infections in splenectomized or non-splenectomized pigs. Etiological agent of acute eperythrozoonosis of swine in the field	Relatively non-pathogenic. May produce mild to severe anæmia in some experimental cases. Not known to produce acute eperythrozoonosis in the field
Prepatent period	6·1 days (average of 43 initial attacks)	13·1 days (average of 21 initial attacks)
Patent rise of infection	3·3 days (average of 43 initial attacks)	7·0 days (average of 21 initial attacks)
Incubation period	9·7 days (average of 43 experimental cases)	26·6 days (average of 3 experimental cases)
Susceptibility to Neoarsphenamine	Highly suceptible to doses of 15 mgm./kgm. or greater	Relatively resistant. Doses of 40–45 mgm./kgm. are effective irregularly
Cross immunity	Pigs pre-mune with *E. suis* are readily infected with *E. parvum*	Pigs pre-mune with *E. parvum* are readily susceptible to acute and fatal infection with *E. suis*
Interference	*E. suis* displaces *E. parvum* when infection is superimposed	*E. parvum* is suppressed in initial mixed infections with *E. suis*
Filterability	Usually retained by the fine diatomaceous earth filters and the Seitz *EK* at negative pressures of 100 mm. mercury	Readily passes the fine diatomaceous earth filters and the Seitz *EK*. Uncomplicated strain may be established by filtration of serum containing the two species

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Dec. 30.

[1] Breed, R. S., Murray, E. G. D., Hitchens, A. P., and the Society of American Bacteriologists, "Bergey's Manual of Determinative Bacteriology", 1111 (Williams and Wilkins Co., 6th edit., 1948).
[2] Foote, L. E., Brock, W. E., and Gallaher, B., *North Amer. Vet.*, **32**, 17 (1951).
[3] Splitter, E. J., *Amer. J. Vet. Res.*, **13**, 290 (1952).

Reversal of the Heart-beat in Tunicates

The periodic reversal of the heart-beat in Tunicates has been considered by us[1] on the basis of the back-pressure theory originally propounded by Lahille[2]. Recently, Millar[3] has concluded from experiments on isolated hearts of *Ciona intestinalis* that the back-pressure theory is untenable.

Although we failed to observe reversals in isolated hearts of *Ascidiella aspersa*, we stated that we saw no reason to suppose that they should not occur. We would not, however, expect them to be regular, and in fact the results quoted by Millar give periods ranging from 1½ to 18½ minutes between reversals. These reversals occurred after several hours of one-way beating, a fact which is in agreement with the back-pressure theory, and only when the heart is very abnormal does the reversal effect become apparent.

It is important to realize the scope of the back-pressure theory. As we have pointed out[1], it merely gives a reason for the stopping of the beat in a particular direction. How the opposite beat afterwards takes over is not explainable in terms of the theory, nor in fact is the mechanism by means of which successive beats one may dominate until reversal.

Millar considers that there is a "pattern of reversal inherent in the heart", but admits that periodic pressure changes may, of course, influence the behaviour of the heart in the intact animal. The regularity of the reversals in the intact animal and the experimental fit to the theoretical that we obtained, as opposed to the wide variations in times between reversals in the isolated heart, are very strong evidence that back-pressure is the controlling mechanism in the intact animal to an overriding extent. In other words, there are two stable modes of action of the heart—abvisceral and advisceral—and back-pressure is the mechanism causing the limitation of one mode in the intact animal. How the transition to the other mode takes place is no concern of the theory. It seems almost certainly to be bound up in some way with the capacity of each end of the heart to initiate contractions. In an isolated and therefore abnormal heart, the beats one way might well be expected to fail to dominate the other consistently, especially when the heart is almost moribund.

We have recently repeated Millar's experiments but did not observe reversal in the isolated hearts of four specimens of *Ciona intestinalis* even after ten hours. However, in two specimens, by merely touching the appropriate end of the heart, reversal could be made to take place at will. In one of the cases the beat continued in the reversed direction, whereas in the other case the reversal was only temporary. It is difficult to know to what extent conclusions can be drawn at all from experiments on hearts not *in situ*, but this is certainly in favour of the idea of two stable modes of action. When reversals occur in the isolated heart without direct mechanical stimulus it could well be due to a variety of causes: local variations in temperature, metabolism, progressive fatigue, weakness of the mechanism controlling the dominance of one mode, etc. It is not, however, valid to conclude that the back-pressure theory is untenable. In fact it seems to us that an "inherent pattern of reversal" can have no significance at all unless it be a *regular* pattern in some way. A mere alternation between the two available directions of beat in circumstances which preclude back-pressure phenomena is insufficient evidence to disprove a verified quantitative theory of the regularity of reversal in the intact animal.

We would stress the need not only for a very thorough re-investigation of the peculiar muscle cells of the Tunicate heart but also the need for definite evidence as to whether the heart is myogenic or neurogenic, before any *complete* theory of the reversal phenomena can be formulated.

C. A. Haywood
H. P. Moon

University College, Leicester.
Jan. 6.

[1] Haywood, C. A., and Moon, H. P., *J. Exp. Biol.*, **27**, 14 (1950).
[2] Lahille, "Contributions à l'étude anatomique et taxonomique des Tuniciers" (Toulouse, 1890).
[3] Millar, R. H., *Nature*, **170**, 851 (1952).

In the above communication, Haywood and Moon stress the irregularity of reversal in the isolated hearts in my experiments, and suggest that the reversal of these hearts is due to their abnormal condition, or to random variations in their environment. It seems to me that the fundamental behaviour of these hearts is their repeated reversal and that it is the irregularity which is more likely to be an abnormality.

However, the most important aspect of the whole question has, I think, been adequately dealt with by von Skramlik[1] in a very important paper which was not referred to in Haywood and Moon's (1950) original contribution. Von Skramlik not only followed the repeated reversal of isolated hearts of *Ciona intestinalis* (after an initial period of one-way beating), but also—and this seems very important—he located a controlling centre at each end of the heart, isolated each of these two centres, and found that each had a rhythmically changing pattern of beating (see von Skramlik, p. 622, Abb. 6), in which series of beats and short pauses alternated. After each pause the isolated controlling centre restarted beating slowly before acquiring its full rate. This activity of the controlling centres is precisely the basis of the "pattern of reversal inherent in the heart" to which I referred in my letter to *Nature*. The heart, therefore, it seems to me, possesses its own mechanism for periodically stopping and reversing, however the action of this mechanism is modified by blood pressure in the intact animal.

A number of other points may also be made in connexion with Haywood and Moon's (1950) paper. They state (p. 15) that "A modified form of the back pressure theory has been put forward by von Skramlik (1930) in which reversal is associated with the periodic contraction of the whole animal, bringing about a reduction of the capacity of the blood vessels by constriction, thus facilitating a build-up of back pressure and subsequent reversal". This statement does not give von Skramlik's view of the activity of the ascidian heart, and in the experiments reported by him (1930) there was no question of "periodic contraction of the whole animal". The contractions in question followed stimulation applied by the experimenter. Von Skramlik states that in the normal, relaxed state of the animal it is the rhythmically varying frequency of beating of the two controlling centres that is responsible for reversal.

Enriques (1904), in stating that there is merely an oscillation of blood to and fro in the vessels, was later proved to be wrong by von Skramlik (1929), who demonstrated a true circulation. Indeed, it is difficult to see what fundamental difference there is in the ascidian blood vessels, as opposed to the system of many other animals possessing a true circulation, which necessitates the application of a theory of back-pressure. But this is an aspect that I would not stress as it depends on measurement of the capacity of different parts of the blood system, which to my knowledge has not been made.

I agree that "It is difficult to know to what extent conclusions can be drawn at all from experiments on hearts not *in situ*", yet this technique has given useful experimental results in other animals. I believe that, when isolated hearts, albeit after an interval of one-way beating, behave in essentially the same way as do hearts *in situ*, and furthermore when an adequate functional basis (rhythmic variation in the controlling centres) is revealed, the conclusion is justified that the tunicate heart has its own inherent pattern of reversal.

R. H. Millar

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Keppel Pier,
Millport.

[1] *Z. vergl. Physiol.*, **4**, 637 (1926).

FORTHCOMING EVENTS

Monday, July 6—Thursday, July 9

Society for Applied Bacteriology (at Oxford).—Summer Conference.

Tuesday, July 7

Symposium on "Antibiotics, their Production and Uses in Industry".

Tuesday, July 7

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Geoffrey Thomas: "An Enquiry into the Mobility of Labour".

Bone and Tooth Society (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Jaw Lesions". (Dr. R. B. Lucas: "Adamantinomas"; Dr. C. H. G. Price: "Osteolytic Mesenchymal Tumors of the Jaw"; Dr. P. Meyer: "Fibrous Dysplasia".)

Tuesday, July 7—Wednesday, July 8

Society for the Study of Fertility (at the University, Liverpool).—Annual Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Glaxo Research Fellowship in Immunology at the Wright-Fleming Institute of Microbiology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (July 10).

Lecturer in Civil Engineering (with honours degree in civil engineering, or equivalent qualifications, and professional or industrial and teaching experience)—The Director, Robert Gordon's Technical College, Aberdeen (July 10).

Head of the Science and Metallurgy Department at the Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough (July 11).

Lecturer in Applied Chemistry (with honours degree or equivalent, and teaching and industrial or research experience)—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 11).

Mycologist (Scientific Officer Grade) and a Crop Physiologist (Scientific Officer Grade)—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, Dundee (July 11).

Assistant Lecturer in Department of Botany—The Registrar, University College, Hull (July 15).

Honours Graduate (with special interest in Plant Physiology and Physics) for research work in the Pomology Section on frost damage to fruit plants—The Secretary, East Malling Research Station, Maidstone, Kent (July 15).

Bashforth Chair of Mathematical Physics in the Royal Military College of Science, Shrivenham—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4222/53 (July 16).

Biologist (preferably Ph.D.; considerable experience in conducting bioassays and in the care of laboratory animals is required) to run the animal laboratory of the Endocrine Unit at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W.6 (July 17).

Assistant Lecturer (with degree in science or dairying and, preferably, with experience in the dairy industry) in Dairying—The Registrar, The University, Reading (July 18).

Assistant Lecturer in Zoology—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (July 18).

International Paints Research Fellowship for biological and chemical research, including research with radioactive substances—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth (July 18).

Scientist (Grade 3) (with good honours degree in geology or chemistry, and some experience or special interest in preparing scientific papers and reports) in the Coal Survey, headquarters staff, London—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/644 (July 18).

University Demonstrator in Physical Chemistry—Dr. F. B. Kipping, Chemical Laboratory, Cambridge (July 18).

Head of the Department of Mechanical Engineering—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (July 20).

Soil Conservation Officers (with degree in conservation, agriculture or agricultural engineering), Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (July 20).

Chair of Zoology and Applied Entomology in the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 23).

District (Forest) Officers (with a university degree in forestry, a university diploma in forestry, or a postgraduate degree in a forestry subject) for service in Great Britain—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 146/53 (July 23).

Demonstrator (with good honours degree and some research experience) in the Department of Physics—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 25).

Experimental Officers and Assistant Experimental Officers (with H.S.C. (Science) or equivalent) at the Atomic Energy Research Establishment, Harwell, for work in physics, chemistry, engineering, chemical engineering and metallurgy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.283/53A (July 25).

Oil Geologist (with considerable experience in the oil industry on production problems, including the consideration of schemes for the large scale development of oil, and familiarity with the regulations governing oil concessions and, preferably, with university degree) in the Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4221/53 (July 30).

Analytical Chemist, Senior Experimental Officer grade (with degree in chemistry or equivalent qualification and experience in analytical work) to collaborate with plant breeders and grassland agronomists in the routine analysis of plant material used in breeding and research work and to take charge and responsibility for the establishment of a chemical laboratory—The Secretary, Welsh Plant Breeding Station, Penglais, Aberystwyth (July 31).

Assistant Lecturer in Psychology with special reference to general and experimental psychology (with honours degree in psychology or equivalent)—The Secretary, University College, Gower Street, London, W.C.1 (July 31).

Physicists (Scientific Officer Class or Experimental Officer Class) in the Ministry of Supply Research and Development Establishments in Malvern, Farnborough, Sevenoaks, and other outstations in southern England (fields of work include aerodynamics and aircraft structures, armaments, instrumentation, radio and radar)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A (August 1).

Research Officer in the Biophysics Subdivision of the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 1).

Lecturer in Mathematics at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

Scientific Officer (Biochemist) at the Royal Belfast Hospital for Sick Children, for research in problems in children—The Secretary, Queen's University, Belfast (August 15).

Teacher of Coalmining (with degree or diploma in mining engineering, and Colliery Manager's Certificate) in the N.S.W. Department of Technical Education, Sydney—The Agent-General for New South Wales, 56-57 Strand, London, W.C.2 (August 17).

National Research Development Corporation Scholarships in the Computing Machine Laboratory—The Registrar, The University, Manchester 13 (September 1).

Entomologist (with special interest in the Parasitic Hymenoptera) at the Commonwealth Institute of Entomology—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (September 15).

Scientific Assistant (with honours degree in biological sciences)—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (September 26).

Agronomist and a Soil Surveyor to work in the Somaliland Protectorate in co-operation with a hydrologist, to select suitable sites for experimental irrigated farms and to prepare the initial layout of the farms—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/5/03–4.

Assistant Lecturer (male) in the Chemistry Department, to give lectures on soils and fertilizers, and to assist at practical classes—The Bursar, Royal Agricultural College, Cirencester.

Assistant Lecturer and Demonstrator in the Physics Department and an Assistant Lecturer and Demonstrator in the Physiology Department—The Secretary, Queen Elizabeth College, Campden Hill Road, London, W.8.

Chemist at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.286/53A.

Civil Engineers (with recognized university degree or diploma in civil engineering) in the Public Works Department, Nigeria, for work on civil engineering and irrigation projects, rural and urban water supplies, road development, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/14/03.

Electrical Engineer for design and specification of electrical equipment for large factories including H.T. and L.T. switchgear, substations and internal installations—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 470.

Engineers (with recognized university degree or diploma in civil engineering) in the Roads Branch, Public Works Department, Kenya, for investigation, design, construction and maintenance of roads, bridges and aerodromes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/7/09.

Entomologist (Biological Control) and an Entomologist (Ecology and Control) for research on the rhinoceros beetle (*Oryctes rhinoceros*) of coconuts—The Secretary-General, South Pacific Commission, Noumea, New Caledonia.

Hydraulic Engineer (with university degree or diploma in civil engineering) in British Honduras, for investigation and development of small irrigation projects, and potable water supplies (boreholes and wells), and the collection of hydrological data generally—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/31/02.

Lecturer, Grade I (with good honours degree in engineering, research and industrial experience) in Mechanical Engineering—The Registrar, The University, Nottingham.

Meteorologist (with honours degree in physics or mathematics, and at least seven years experience in meteorological office or meteorological branch of the Royal Navy, with some service in the tropics, and fully conversant with I.C.A.O. procedures) in the Gold Coast, for supervision of Accra Forecasting Office and related work of outstations, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.57/13/C2.

Mineralogist (with second-class honours degree, division I in geology, and specialized in mineralogy and petrology, with one year's postgraduate research experience) in the Geological Survey Department, Nigeria—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.105/14/04.